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WORK OF THE SCOTTS BLUFF FIELD STATION 1922 TO 1925

JAMES A. HOLDEN, *Associate Agronomist and Superintendent, Office of Western Irrigation Agriculture, Bureau of Plant Industry*

THE UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE NEBRASKA AGRICULTURAL EXPERIMENT STATION

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INTRODUCTION

The Scotts Bluff Field Station is situated on the North Platte reclamation project, in Scotts Bluff County, Nebr., about 6 miles east of the town of Mitchell and about 8 miles northwest of the town of Scottsbluff. The experiment farm comprises 160 acres of irrigable land, but a part of it is used without irrigation for dry-land experiments. In addition there is a dry-land pasture of 800 acres 5 miles to the north which is representative of the range lands that surround the project.

The work of the station is conducted cooperatively by the United States Department of Agriculture and the Nebraska Agricultural Experiment Station. The aim of this experimental work is to gather information of practical value concerning agricultural problems on irrigated farms as well as to deal with the more general problems of crop production and crop utilization. Operations at the station were begun in 1909.

This report is intended to summarize the more important lines of work conducted at the station, with special emphasis on the results obtained during the years 1922, 1923, 1924, and 1925. A brief survey is also made of the agricultural development of the North Platte reclamation project.

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CONDITIONS ON THE NORTH PLATTE RECLAMATION PROJECT

CLIMATE

During the years 1922 to 1925, inclusive, the weather conditions affecting crop growth on the project varied.

In 1922 conditions were very favorable, except, perhaps, that the high temperature during August favored early blight on potatoes. The precipitation was slightly above normal, but a large part of it fell during the early growing season. The growing season was 148 days, and the winter was about normal, with a minimum temperature of 20° F. below zero.

The early spring of 1923 was unusually favorable; the soil was well supplied with moisture and the spring work began early and was uninterrupted by storms until after most of the small grains and sugar beets were planted. Most of the sugar beets were up and looked very promising when, on May 16, a severe freeze occurred which made it necessary to reseed about 16,000 acres. Severe rainstorms followed the freeze and caused more damage. The precipitation for the year was much above normal, the greater part of it falling during June, July, and August. Fall frosts were so late that the growing period extended to 150 days, but the winter was rather severe, the minimum temperature being 34° below zero, the lowest temperature recorded at the station since its establishment.

Due largely to a lack of moisture for germination, especially of the sugar-beet seed, the spring of 1924 was unfavorable; but the latter part of the summer was ideal for plant growth. The total precipitation for the year was the lowest in the history of the station, being less than half of that of the preceding year. The growing season was 143 days, and the winter was rather mild except for about a week of severe weather the latter part of December.

The growing season of 1925 was perhaps the most favorable in the history of the project. While the early spring was so dry that sugar-beet seed did not germinate, the drought was broken on May 14 by a rain of 1.1 inches, and this was followed by others, which supplied sufficient moisture to give all crops a good start. Although the total precipitation for the year was only 13.57 inches, which is less than normal, the greater part of it fell during May, June, and July, when most needed. The irrigation water was sufficient to meet the needs of most crops. The last frost in the spring occurred May 5 and the first fall frost October 6, making a total growing period of 154 days, which is 19 days longer than normal. The yield of all crops was unusually high and of good quality. Most of October was very unfavorable for harvesting, due to snow and cold weather. For a time it seemed as if nearly one-half of the sugar-beet crop would remain unharvested, but weather conditions cleared up November 7 and continued good the remainder of the month, and the sugar-beet crop was harvested. A few acres of potatoes were still undug when the cold weather began, and much damage was done, although the greater part of the potato crop was harvested free of frost. The winter months were much milder than usual, 13° F. below zero being the minimum temperature for the year.

A summarized statement of the climatological data is given in Table 1.

TABLE 1.—*Summary of climatological observations made at the Scotts Bluff Field Station, 1911–1925*

PRECIPITATION (INCHES)

Item	January	February	March	April	May	June	July	August	September	October	November	December	Total
Average, 1911–1925	0.17	0.19	0.51	1.88	2.87	2.05	1.75	1.61	1.70	1.02	0.38	0.44	14.57
1922	.02	.03	.15	3.49	3.72	1.16	3.67	.27	.36	.04	2.54	.21	15.66
1923	0	.03	.03	.30	2.85	5.40	3.37	3.40	1.28	2.54	.62	.38	20.20
1924	0	.08	.61	.64	1.65	1.00	1.05	.40	2.98	1.06	.02	.27	9.76
1925	0	.03	.61	.74	3.40	4.05	1.27	.33	.76	1.80	.05	.53	13.57

EVAPORATION (INCHES)

Average, 1911–1925	-----	-----	-----	4.28	6.00	6.46	7.73	6.33	5.09	-----	-----	-----	35.89
1922	-----	-----	-----	2.51	6.49	6.12	6.72	6.83	5.44	-----	-----	-----	34.11
1923	-----	-----	-----	3.38	5.06	6.93	6.31	5.24	4.90	-----	-----	-----	31.82
1924	-----	-----	-----	2.46	4.89	6.66	7.47	7.22	4.63	-----	-----	-----	33.33
1925	-----	-----	-----	5.41	6.17	6.87	8.17	6.07	4.96	-----	-----	-----	37.65

DAILY WIND VELOCITY (MILES PER HOUR)

Highest:													
1911–1925	29.9	24.5	26.0	31.4	30.8	18.1	11.1	10.5	14.7	23.1	27.2	18.2	-----
1922	17.4	15.9	24.4	29.2	30.8	16.5	11.1	9.1	10.5	17.8	27.2	18.2	-----
1923	24.8	17.5	26.0	22.7	10.7	11.6	6.1	7.6	10.1	13.0	15.0	16.2	-----
1924	10.9	23.5	15.5	22.8	21.3	13.9	9.9	10.5	12.0	17.5	14.0	15.6	-----
1925	15.9	13.3	22.2	18.5	15.2	18.1	11.0	9.5	14.7	15.7	13.5	16.5	-----
Lowest:													
1911–1925	.8	.4	.5	1.4	.1	.1	.4	.2	.1	.8	.5	.3	-----
1922	2.4	3.7	2.1	5.1	6.0	3.3	2.5	3.2	2.7	2.7	2.7	1.8	-----
1923	4.7	2.3	4.6	3.0	3.4	3.4	3.0	2.0	2.3	1.4	2.2	2.6	-----
1924	2.5	2.7	2.7	3.7	1.8	3.6	3.2	2.0	2.5	2.3	3.5	3.6	-----
1925	1.7	2.7	3.8	4.2	4.0	2.8	3.5	2.0	2.1	1.7	3.0	2.1	-----
Mean:													
1911–1925	6.6	6.4	7.8	8.3	7.7	6.2	4.6	4.2	4.5	5.5	5.3	5.8	-----
1922	9.7	8.0	10.3	11.8	12.6	5.9	4.9	4.5	3.6	5.5	6.8	7.4	-----
1923	9.1	7.4	11.9	9.3	9.1	8.4	5.1	4.9	5.8	5.6	5.6	6.3	-----
1924	5.5	7.1	8.9	9.1	8.4	8.0	6.7	6.2	6.5	8.0	8.2	9.0	-----
1925	8.7	8.2	10.3	10.4	8.4	8.6	6.0	5.2	6.0	7.7	6.6	7.9	-----

TEMPERATURE (° F.)

Absolute maximum:													
1911–1925	68	72	81	95	92	101	101	99	94	91	75	90	-----
1922	52	72	71	73	81	98	98	94	93	91	56	58	-----
1923	60	60	64	82	85	89	98	92	92	72	67	53	-----
1924	55	65	59	84	86	97	96	99	93	79	77	67	-----
1925	59	67	74	82	92	92	101	95	93	83	63	61	-----
Absolute minimum:													
1911–1925	−28	−23	−15	−2	22	30	37	40	22	−4	−21	−34	-----
1922	−20	−9	−7	16	30	34	37	49	40	12	5	−9	-----
1923	1	−19	−14	20	25	43	49	41	36	6	8	−34	-----
1924	−22	−7	1	17	21	36	45	41	32	24	11	−22	-----
1925	−13	8	−3	16	28	38	43	46	31	−4	12	−12	-----
Mean.													
1911–1925	24	27	34	40	55	65	71	69	59	46	36	23	-----
1922	19	24	36	43	57	67	69	74	64	50	33	26	-----
1923	32	24	31	44	55	65	74	68	61	45	37	27	-----
1924	20	34	29	49	52	67	70	71	59	52	38	20	-----
1925	25	36	38	48	59	66	72	69	62	38	37	14	-----

TABLE 1.—*Summary of climatological observations made at the Scotts Bluff Field Station, 1911–1925*—Continued

KILLING FROSTS

Year	Last in spring		First in fall		Length of frost-free period (days)
	Date	Minimum temperature (° F.)	Date	Minimum temperature (° F.)	
1911	May 26	28	Oct. 3	31	130
1912	May 13	30	Sept. 16	31	126
1913	May 2	26	Sept. 19	31	140
1914	May 7	32	Sept. 13	30	129
1915	June 12	32	Oct. 3	32	113
1916	May 2	24	Sept. 14	30	135
1917	May 21	32	Oct. 7	28	139
1918	May 9	31	Sept. 15	32	129
1919	June 2	30	Sept. 21	32	111
1920	May 7	30	Sept. 26	31	142
1921	May 12	28	Sept. 29	31	140
1922	May 13	30	Oct. 8	23	148
1923	May 16	25	Oct. 13	22	150
1924	May 15	21	Oct. 5	24	143
1925	May 5	28	Oct. 6	26	154

CROP CONDITIONS [1]

The yields of crops for the years 1922 to 1925, inclusive, on the North Platte project were very good in some cases and extremely low in others. The total farm acreage has decreased somewhat on account of the generally adverse financial conditions in agriculture. This decrease has come about by the abandonment of some of the poorer farms. The acreage of the various major crops shows considerable fluctuation. Alfalfa, oats, and wheat show a decline, while corn, barley, and sweet clover show an increase. The acreage of potatoes was very high in 1922 but has decreased with each succeeding year. The sugar-beet acreage does not change greatly from year to year, although it is now less than it was in 1920. A summary of the acreage of the principal crops grown on the project since 1910 is given in Table 2.

SUGAR BEETS

The 1922 sugar-beet yield was 13.4 tons per acre; the following year the average yield was less by 2.1 tons, due largely to frost damage May 16. For 1924 the average yield was 12.1 tons, and for 1925 it was 14.9 tons per acre. This last is the highest average yield ever reported for the project. The price varied from $8.18 a ton for the 1923 crop to $6 a ton for that of 1925, with a four-year average of $7.42. It is generally conceded that a 10-ton yield per acre is necessary to cover the cost of production. On this basis the net return per acre from sugar beets grown on the project amounted to more than the gross returns per acre from such crops as alfalfa, corn, or any of the small grains. In 1922, 1923, and 1924 the sugar-beet crop, which occupied only 14.2 per cent of the total cropped area, brought to the project considerably more than a million dollars each year, which was more than the combined value of all the other crops.

[1] The statistics used in this discussion, unless otherwise stated, apply to the interstate unit of the North Platte reclamation project and were obtained from Reclamation Bureau records.

POTATOES

The potato crops of 1922 and 1923 were financial losses, that of 1924 showed some improvement, while the crop of 1925 was highly profitable. Stimulated by the high prices received for the 1921 crop, the potato acreage was increased to a total of 13,312 acres in 1922, being higher by more than 4,000 acres than in the preceding year, when it was well above normal. Seed was very expensive, harvesting costs were high, yields were low, on account of damage from early blight which developed during August, and market prices were so low that the returns from the crop did not even approximate the cost of production. In addition to all this, many potatoes were damaged by frost, which not only cut down the proportion of marketable potatoes but added greatly to the expense of sorting. All in all, it is doubtful if the total returns amounted to as much as the expense of harvesting the crop. As a matter of fact, more than 1,200 acres were not harvested. In many instances the net returns from carload shipments were less than the cost of the sacks.

TABLE 2.—*Acreage of the principal crops grown on the North Platte reclamation project, period 1910–1925*

Year	All crops	Alfalfa	Sugar beets	Potatoes	Corn	Barley	Oats	Wheat
1910	42,362	3,707	283	3,854	5,207	1,138	11,419	9,597
1911	44,736	8,880	343	3,190	4,563	902	12,271	6,715
1912	50,250	19,512	667	1,192	6,260	1,156	10,093	4,390
1913	56,829	27,298	2,920	1,156	3,561	2,331	8,590	2,182
1914	60,532	32,464	5,083	1,097	6,024	2,261	7,017	609
1915	70,007	31,788	7,872	1,395	10,343	2,329	7,112	1,878
1916	75,620	32,601	9,024	1,735	6,715	4,857	10,375	2,617
1917	82,537	34,374	9,357	4,833	6,051	3,052	10,173	3,128
1918	86,464	37,863	6,391	6,203	6,627	3,550	7,997	9,097
1919	87,022	33,446	10,968	6,284	9,107	3,720	6,620	9,757
1920	86,919	31,625	16,558	5,799	10,176	3,922	7,708	5,971
1921	86,148	31,056	14,844	9,300	9,462	3,413	9,504	4,552
1922	87,300	27,662	10,614	13,312	11,614	3,932	6,781	7,810
1923	87,404	25,467	11,527	7,903	21,054	5,175	4,847	4,928
1924	81,888	23,357	14,322	5,051	17,472	7,642	4,265	2,080
1925	84,116	21,057	12,112	4,652	21,224	9,926	3,645	1,624

The potato acreage in 1923 was reduced by more than 5,400 acres, but was still above the average for the first seven years. Seed was much cheaper than in the preceding year, harvesting expenses were less, and market prices were still low but considerably improved. However, as the result of another attack of blight, the acre yield in most cases was so low that the crop on the whole was a financial loss.

In 1924 the potato acreage was again reduced, being less than 38 per cent of that for 1922. The yield, however, was much better, the quality improved, and although prices were perhaps no higher than in the preceding year, the Triumph variety, which comprises the greater part of the crop, sold at a premium and thus brought a higher price per bushel than did the 1923 crop. The cost of seed and harvesting were relatively low and the yield of marketable potatoes was high, so that the crop in many cases showed a small profit.

The potato acreage was further reduced in 1925. The yield was high, the quality very good, and prices varied from 90 cents to more than $2 a bushel. In short, the potato crop was highly profitable. Figures furnished by the Reclamation Bureau show that the average

acre yield was 201 bushels, and that the average price per bushel was $1.05, which makes an average acre return of $211.05 as against an average of $42.48 for the three previous years.

In 1925 the potato acreage represented 5.5 per cent of the total cropped area of the project, while the returns from this crop amounted to 31 per cent of the returns from all crops. The only safe practice in growing potatoes on the North Platte project is to grow the same acreage every year in a cropping system where the potatoes follow either alfalfa or sweet clover, with at least three consecutive years in which potatoes do not come on the same field.

ALFALFA AND SWEET CLOVER

Under the system of farming generally followed on the project the greater part of the crops are hauled off the farm instead of being fed and then returned to the land in the form of manure. The productiveness of the soil can be maintained under this system only by a liberal use of alfalfa or sweet clover in the cropping system. From a practical standpoint, three or four crops are as many as should be grown on land after it is broken out from alfalfa or sweet clover before it is again seeded down. If a crop-rotation system is followed, about half of the farm should be in alfalfa or sweet clover all the time, and these crops should be rotated from field to field with the other crops. If a liberal use is made of alfalfa and sweet clover in the cropping system, high yields of cultivated crops can be obtained, at least for a long time, without the use of manure.

The potential or latent fertilizing power of alfalfa which results in increased production of succeeding crops, especially on poor land, is of greater value to potato or sugar-beet growers on the North Platte project than the actual alfalfa crop itself. This residual effect is well understood by most project farmers. It is now less difficult to induce farmers to plow up their old alfalfa than it is to persuade them to seed the land back to alfalfa before the soil has become unduly run down. This does not in all cases represent a lack of vision but a disposition on the part of farmers to gamble on the future. Frequently there has been a tendency to hold on, if possible, until financial conditions improve, in the hope than an opportunity may present itself either to sell or to take time for soil improvement.

Grasshoppers also have been a very great handicap in getting a new stand of alfalfa since 1918. In some years and in some localitites this pest has been more serious than in others. Although formerly it was a very simple matter to get a good stand of alfalfa, it has lately become a very difficult problem.

The grasshopper invasion, as well as the advantages of turning under old alfalfa, are largely responsible for the small and decreasing acreage of alfalfa. In 1918 there were 37,863 acres of alfalfa on the project as against 21,057 acres in 1925. On an average there were 22 acres of alfalfa per 80-acre farm in 1918, but only 16.6 acres in 1925. In either case the acreage is far too small, if not from the standpoint of the hay crop, certainly from that of sustaining soil productiveness.

This decrease in the alfalfa acreage would be more serious if it were not for the fact that sweet clover is being used in its place. Grasshoppers do but little damage to young sweet clover, it is a safer pasture crop than alfalfa for cattle and sheep, and its beneficial effect

on the land, especially when pastured, is equal to that of alfalfa. These advantages, especially its immunity from the grasshopper menace, have made sweet clover a popular crop during recent years. In 1920 there were only 378 acres on the project, in comparison with 3,332 acres in 1925.

CORN

The corn acreage also has increased since 1921, notwithstanding the fact that the average acre return from this crop is the lowest of any major crop grown on the project. This low return is not due to adverse climatic conditions but to poor farming. Corn has nearly always been the most neglected crop on the project. In early years it was believed that the season was too short for profitable corn yields. What corn was planted was usually put on poor land and given little or no care. It soon became evident, however, that corn could be made as profitable as some of the other crops if given the same care. Many farmers, especially those at a considerable distance from a sugar-beet dump, began using corn in their regular cropping system, with very satisfactory results. Yields of 50 to 60 bushels per acre when grown under proper conditions are rather common, but still there are enough neglected fields to bring the average yield for the project down to a low level.

In 1921, because of economic conditions, there began a migration from the farm. This movement was rather general from some of the poorer sections of the project. Some of these farms were abandoned entirely, while others were farmed by some neighbor who already had more land than he could care for properly. In the main these poorer farms were planted to corn by using a lister, in order to cover a large acreage with as little time and expense as possible. The crop usually received very little care after planting, either as to irrigation or cultivation. In most cases the yields from such fields are very low and are largely responsible for the low average acre yield for the project. A 23-bushel yield of corn, which was the average acre yield for the project in 1925 and is the highest in the history of the project, is by no means a fair indication of the possibility of the corn crop. Speaking generally, corn is a profitable crop to grow in the North Platte Valley, provided it is given proper care and attention.

SMALL GRAINS

The barley acreage seems to be on the increase, whereas that of both oats and wheat is decreasing. This change is in the right direction, as barley will usually produce more pounds per acre than either of the other two grains. To compare the yields in terms of bushels is often misleading. When fed with alfalfa hay, the feeding value by weight of these grains does not differ widely. Wheat is shipped out of the valley and the feed grains are shipped into the valley; consequently, when the cost of freight is added to the feed grains the local cost per pound is nearly equal to that of wheat. The value of the small gains as nurse crops for alfalfa or sweet clover is the only justification for growing them on irrigated land. In this connection it may be stated that there was apparently no appreciable difference in the effect of barley, oats, and wheat as nurse crops for alfalfa or sweet clover.

Small grain when seeded alone is usually grown at an economic loss on high-priced irrigated land, but in a cropping system in which the land is frequently seeded to alfalfa or sweet clover the seeding of a grain crop with the legume crop is usually advantageous because of the increased returns which may be expected from the land the year the seeding is made. The straw from the grain crop is also valuable when livestock are kept on the farm. When grasshoppers are bad, however, it is easier to get a stand of alfalfa by seeding it alone. Grain plays another rôle in getting sandy land seeded down to alfalfa or sweet clover. Where the soil drifts badly it often becomes necessary to seed grain on the land first, in order to get a stubble which will prevent the soil from drifting, the alfalfa or sweet clover being seeded in the undisturbed stubble the following spring. A disk drill set shallow, the seed being put down the shoes, is a good implement to use in making this seeding.

LIVESTOCK

Two methods are used in the North Platte Valley in improving the productiveness of the soil. One is the growing of alfalfa or sweet clover on the land, and the other is the application of barnyard manure. Whether alfalfa and sweet clover shall be grown or livestock fed is determined largely by the ultimate influence of these practices on the yields of potatoes, corn, and sugar beets. The tendency therefore, is to keep the kind of livestock that will not only aid soil fertility but also compete as little as possible with the labor required in growing these crops. From the standpoint of labor, winter feeding is more convenient; but as sweet clover, which is rapidly increasing in acreage, can be utilized best as a pasture crop, the keeping of livestock during the summer has its advantages. Dairy cows and sheep do especially well on sweet-clover pasture.

DAIRYING

The dairy industry, as is usually the case during a period of general agricultural depression following a period of high crop prices, has been greatly increased. From the nature of the work dairying is intensely confining, and there is therefore a strong tendency for the farmer to get away from dairying when conditions are such that an equal profit can be made from another system of farming. During and just after the World War prices of field crops were high and prices of dairy products were relatively low. The high price of one and the low price of the other worked to the same end—overproduction of field crops and underproduction of dairy products—with a consequent change in relative prices.

The factors which have stimulated dairying in other sections have also had their influence on the farmers of the North Platte project. A keen interest in dairying has been developed, rather as a part of the regular farming scheme than as a specialized industry. The ultimate aim in most cases seems to be to keep enough cows so that the returns from this source, together with the returns from poultry, will meet the running expenses of the family. Considerable progress in this direction is being made, and the encouraging part is that this is being accomplished largely by the use of good dairy sires rather

than by the expensive method of shipping in high-priced cows from other dairy sections.

A much keener interest in the breeding up of the herd is now manifest. More and better sires are in use on the project than ever before. Farmers in general are coming to realize that the development of the dairy herd by means of good dairy sires is practicable and that this method is the most profitable also. The Scotts Bluff Field Station, cooperating with the Office of Demonstrations on Reclamation Projects, Extension Service, United States Department of Agriculture, has been a factor in this movement. Assistance has been given by the distribution of suitable sires as well as by pointing out their importance in developing the herd. There are in the valley a number of very good purebred dairy herds from which bulls are available at reasonable prices. To encourage the use of good sires, bulls from the station herd are lent to groups of farmers with small herds, who form themselves into bull associations. At the close of 1925 there were eight such bulls in service on the project.

Sweet clover is playing an important part in this dairy movement and no doubt will have a marked influence on its future development. Dairying without suitable pasture is handicapped. Grass pasture which requires frequent irrigation and manuring has made little progress, but with sweet clover, a crop which has an unusually large carrying capacity, requires no larger amount of water, improves the land, and does not require manure, the pasture problem is largely solved. Dairy cows do as well on sweet-clover pasture as they do on bluegrass pasture.

SHEEP FEEDING

Feeding sheep, especially lambs, is becoming one of the leading livestock industries on the project. It fits in well with the general type of farming practiced. The lambs are generally put into the feed lots after all harvesting is completed and are shipped to market before spring work begins. The number of lamb feeders is increasing, but the average number of lambs per feeder is decreasing. Lamb feeding is often looked upon as speculation, and in too many cases it is. Feeding lambs under proper conditions, however, is no more speculative than the growing of potatoes. Too often the trouble with beginners is that they think and talk in terms of thousands instead of hundreds. For a beginner to feed as many as 2,000 lambs when he must buy most of his feed is pure speculation; but if he would cut down the number to one or two carloads, so that he would have most of his own feed, the venture would be much less speculative. Such feeding should be encouraged. The farmer who has his own hay, beet tops, and perhaps some barley should have no difficulty in getting his banker to finance him in the feeding of one or two carloads of lambs. It is true that there are bad years in which feeders will lose, but there are far more good years than bad ones, so that if a farmer feeds approximately the same number every year he should make a profit over a period of years.

Another phase of the sheep-feeding industry is lambing out broken-mouthed ewes. Those bred for January lambing are marketed in the early spring along with the lambs. Ewes and lambs are fed all the grain they will eat for a period beginning soon after the lambs are dropped and lasting until both ewes and lambs are sent to market.

The lambs usually weigh between 60 and 70 pounds and are known as hothouse lambs. The ewes are bred on the range, usually in the mountains. After they are received at the farm ewes intended for later lambing are as a rule bred to black-face rams. These ewes and their lambs are usually grazed on sweet-clover pasture supplemented by grain and are marketed during the summer or fall, depending largely on the time the lambs were dropped. Ewes of this class, bred for late lambing, can utilize the increasing acreage of sweet clover to very good advantage.

CATTLE FEEDING

The number of cattle finished on project farms is becoming less each year. Feeders are shifting from cattle to lambs. The principal reason for this is that cattle feeding in general has been unprofitable, while lamb feeding has been profitable. Cattle are still used by farmers, however, to consume their sugar-beet tops. Two methods are used. In one case the tops are pastured on the land and the cattle are not fed any additional feed, and in the other case the tops are hauled from the field and fed to the cattle in yards, usually with alfalfa hay. The latter method is gaining in favor. More feed is wasted when the tops are pastured, and the running of the cattle over the land causes the soil to blow badly. Another advantage of feeding beet tops in yards is that by a liberal use of bedding more manure is produced. A large number of cattle are fed near the sugar factory at the town of Scottsbluff, where wet pulp is available. These cattle are usually shipped to market in late spring or summer. Alfalfa hay or straw is fed with the wet pulp, and during the finishing period cottonseed meal or linseed meal and sometimes corn is added to the ration.

HOG RAISING

The hog industry is slowly recovering from the slump suffered during the period, 1917 to 1921, inclusive. According to the project census, the number of hogs was 25,123 in 1916 and only 7,263 in 1921. Since the latter year it has increased to 9,654 in 1925.

THE WORK OF THE STATION

CROP ROTATION UNDER IRRIGATION

At the Scotts Bluff Field Station the irrigated rotations occupy 97 quarter-acre plots divided into 34 different cropping systems, 31 of which were begun in 1912, 3 being added in 1920. There are nine continuous cropping experiments; eleven 2-year, three 3-year, five 4-year, five 6-year, and one 7-year rotation experiments. Three 2-year, one 3-year, one 6-year, and one 7-year rotation plots receive barnyard manure once during the period of the rotation at the rate of 12 tons an acre. The crops grown include alfalfa, sugar beets, corn, flax, oats, potatoes, spring wheat, winter wheat, and sweet clover. One plot of corn and one of alfalfa are harvested by hogs, and one plot of sweet clover is harvested by sheep.

By crop rotation is meant the growing of two or more crops in a fixed cropping scheme wherein one crop follows another in a definite order, and it requires as many years as there are crops grown to complete the cycle. In these experiments there are as many plots

as there are years in the cropping systems, so that each crop in the rotation is grown every year.

In arranging these different cropping systems in the field, the aim was to place comparative rotations as near to one another as possible and at the same time arrange them so that the irrigation water from alfalfa, sweet clover, or manured rotations would not be picked up and used on plots in cropping systems not having alfalfa, sweet clover, or manure.

The soil of the field station is a light sandy loam, fairly representative of the soil under the Interstate Canal. It is comparatively uniform, well drained, and easily irrigated. The yields of all crops on the station, except legumes, decrease rapidly after the second or third year unless manure is applied or a legume crop such as alfalfa or sweet clover is grown on the land at frequent intervals, indicating that the soil is not especially well supplied with all the requirements of crop growth in available form. The land was broken from sod and seeded to oats one year before the rotation experiment began in 1912.

Similar crops in all rotations are treated alike as regards the variety, quantity, and quality of seed used; the date of planting, cultivation, and irrigation. In other words, the cultural practices are the same. The only variation is the difference in the rotation or in the application of manure. Any difference in yields, therefore, is due to the effect of the cropping system or to the manure applied.

There has been a noticeable difference in yields of the same crop when grown in the various cropping systems. Early in the experiment, crops following either potatoes or sugar beets yielded more than those following corn or small grain. This was especially noticeable in the yield of oats. Oats on disked potato land or disked sugar-beet land yielded about 45 per cent more than on disked corn land. Potatoes following sugar beets yielded as much as when they followed manured oats. But this difference in favor of potato and sugar-beet land has gradually disappeared until there is now but little difference. The outstanding differences in yields are due to the beneficial effect of alfalfa, sweet clover, and barnyard manure. These differences have been very consistent throughout the experiment.

The plots that received no manure or that have never produced alfalfa or sweet clover gave much higher yields during the first three years than they did the last three years. The manured plots and the plots previously in alfalfa or sweet clover yielded about the same for both periods. The spread in yields, therefore, from these differently treated plots is accounted for by a decreased yield from the plots not receiving manure nor having alfalfa or sweet clover, rather than to an increase from the manured, alfalfa, or sweet-clover plots.

If the results of the first five years of the crop-rotation tests are omitted the average yields for the next nine years are compared, the beneficial effect of manure and these legume crops is apparent. Sugar beets on unmanured land yielded 10 tons an acre; on manured land, 17.9 tons; on alfalfa land the second and third year after it was plowed up, 17.5 tons; on alfalfa land manured, 19.4 tons; and on pastured sweet clover land, 20.1 tons. This is an increase of 7.9 tons from the application of manure, 7.5 tons from the growing of alfalfa in the rotation, 9.4 tons from both alfalfa and manure, and 10.1 tons from pasturing second-year sweet clover on the land.

Potatoes yielded 125 bushels on unmanured land, 217 bushels on manured land, and 287 bushels when following alfalfa. In other words, there was an increase of 92 bushels from manure and 162 bushels following alfalfa. The average yield of corn was 33 bushels on unmanured land and 61 bushels on alfalfa land. Oats yielded 45 bushels on unmanured land, 67 bushels on manured land, and 69 bushels on alfalfa land. Wheat yielded 17 bushels on unmanured land and 27 bushels when following alfalfa. Weeds have been very troublesome in the flax plots, making it impossible to harvest the crop.

In 1925 the yields of all crops in the rotations were uniformly good. The season was not favorable to one crop and unfavorable to another. The yields of the different crops grown on unmanured, manured, alfalfa, or sweet-clover land will, therefore, show the beneficial effect of each on the yields of succeeding crops. Table 3 gives these yields when figured on an acre basis.

TABLE 3.—*Acre yields of crops grown in rotation experiments, showing effect of manure, alfalfa, and sweet clover on yields of different crops in 1925, at the Scotts Bluff Field Station*

Cultural conditions	Potatoes	Sugar beets	Corn	Oats	Wheat
	Bushels	*Tons*	*Bushels*	*Bushels*	*Bushels*
Unmanured	207.0	12.1	40.0	43.0	11.0
Manured	386.0	21.7	----------	67.0	----------
Following alfalfa, unmanured	409.6	19.3	75.0	90.0	28.0
Following alfalfa, manured	----------	23.1	----------	96.0	----------
Following sweet clover, pastured	----------	21.2	----------	54.0	----------

The crop yield of the fourteenth year, as given in the table, plainly shows the value of manure, alfalfa, and sweet clover in keeping up the productiveness of the land. Where no manure is applied or no alfalfa or sweet clover grown on the land at frequent intervals, it soon loses its productive power and the yields become so low that they are unprofitable.

From results obtained during the last 14 years from these 34 different crop rotation systems, it is evident that the cropping system followed by the farmers of the North Platte Valley determines in a large measure the success or failure of the farming operations. If the farmer follows a well-planned cropping system and properly cares for the crop, he should realize a profit, but if he follows a poor cropping system he will lose money, even though he gives his crops the best of care.

Each crop used in these rotations is here considered separately.

ALFALFA

Alfalfa is grown on 27 plots in 11 different cropping systems. The rotation experiments include one continuously cropped plot, four 4-year, five 6-year, and one 7-year rotation plots. In two of the 4-year rotations and three of the 6-year rotations the alfalfa is seeded alone on sugar-beet land; in two 4-year and one 6-year rotation it is seeded in oat stubble about the middle of August after the grain is removed; and in one 6-year and one 7-year rotation the alfalfa is seeded on sugar-beet land with oats as a nurse crop. Each spring the oldest plot of alfalfa in each rotation is plowed up. In

the 4-year rotations the alfalfa is plowed up in the spring following the second summer. In the 6-year rotations the alfalfa is plowed up in the spring following the third summer after being seeded, except in the case of the plot in which alfalfa is seeded with a nurse crop, in which case it is plowed up the fourth spring. The alfalfa in the 7-year rotation is plowed up the fourth spring after being seeded. Ten new plots of alfalfa are seeded and 10 old plots are plowed up each year. Potatoes are planted on seven of these old alfalfa plots, corn on two, and spring wheat on one.

A grain drill with an alfalfa seed attachment is used in seeding the alfalfa. Where the alfalfa is seeded alone the seed is put down through the shoe, but when it is seeded with grain the grain is put down through the shoe and the alfalfa is broadcast just in front of the disks of the drill. The alfalfa seed would be covered too deep if put down through the shoe with the grain. Many failures in getting a stand of alfalfa are the result of too deep seeding. About 12 pounds of good clean seed are sown per acre. The common alfalfa seems to do as well as the other varieties, and as a rule the seed is much cheaper.

The results from these different methods of seeding show that under normal conditions the most practical method is to seed alfalfa in the spring with a grain crop. Experience has shown, however, that during grasshopper plagues it is easier to get a good stand of alfalfa when it is seeded alone than when it is seeded with grain. When it is seeded alone, weeds and grass become very troublesome and retard the growth of the young alfalfa as much perhaps as the grain crop does. Very little hay is produced the first year from alfalfa seeded alone in the spring. The weeds and grass are clipped with a mower often enough to prevent them from smothering out the alfalfa. When there were no grasshoppers it was very easy to get an excellent stand by seeding the alfalfa in the grain stubble soon after August 15; but since 1918, when grasshoppers first became very bad, every fall seeding has been a failure, making it necessary to reseed these plots the following spring. The land is plowed just before the reseeding is done. The alfalfa is usually seeded in the spring between April 10 and the first week in May. The earlier the alfalfa can get started the better chance it has of withstanding the damage from grasshoppers.

The crop rotation seems to have little or no effect on the yields of alfalfa. The unmanured rotations produce as much hay as those that receive manure. The main requirement of alfalfa is plenty of water. Alfalfa will not do well, however, on seeped land or on land in which the water table is near the surface.

SUGAR BEETS

Sugar beets are grown on 19 plots in 17 different cropping systems. Fourteen of them were begun in 1912, and the other three in 1920. On one plot sugar beets are grown continuously, the 1925 crop being the fourteenth consecutive beet crop. There are five 2-year, three 3-year, three 4-year, four 6-year, and one 7-year rotations. Two of the 2-year and one each of the 3-year, 6-year, and 7-year rotations receive manure at the rate of 12 tons per acre once in the rotation period. In four of the manured rotations sugar beets follow the manure, while in one 2-year rotation they follow potatoes that have

been manured. In one rotation two crops of sugar beets follow pastured sweet clover. Sugar beets follow alfalfa the second year in four cases and the third year in two cases, after the alfalfa is plowed up. Two of the rotations in which sugar beets follow alfalfa also receive manure the third season. In these different rotations sugar beets follow spring wheat, oats, potatoes, and sweet clover.

There has been a marked difference in yields of sugar beets from these various rotations. At the beginning of the experiment, sugar beets following potatoes gave higher yields than they did when following a grain crop. This difference, however, has largely disappeared. On good productive land sugar beets follow potatoes with very good results, but poor run-out land can not be improved for sugar beets by growing potatoes on it. At the end of the thirteenth year the previous crops, with the exception of alfalfa and sweet clover, seem to have little influence on the sugar-beet crop. The yields of sugar beets in rotations which include alfalfa or sweet clover or which receive manure have been consistently higher than those from the other rotations. The differences in tons per acre are shown in the last four right-hand columns of Table 4, which gives a summary by three-year periods of sugar beets grown under different conditions with reference to manure, alfalfa, and sweet clover.

TABLE 4.—*Summary by three-year periods and for 1925 of the yields of sugar beets from irrigated rotations, Scotts Bluff Field Station, 1912–1925, omitting 1916*

Period	Average acre yield (tons) of—					Increase in favor of—			
	Control, 6 plots	Manured, 3 plots	Alfalfa, 6 plots	Manured alfalfa, 2 plots	Sweet clover, 2 plots	Manure	Alfalfa	Manured alfalfa	Sweet clover
1912–1914	16.4	20.7	--------	--------	--------	4.3	--------	--------	--------
1915–1918	11.3	17.7	16.5	19.4	--------	6.4	5.2	8.1	--------
1919–1921	8.1	14.7	14.0	16.2	--------	6.6	5.9	8.1	--------
1922–1924	10.3	19.2	18.1	20.8	19.5	8.9	7.8	10.5	9.2
1925	12.1	21.7	19.3	23.1	21.2	9.6	7.2	11.0	9.1
Average	11.5	18.3	16.5	19.2	19.9	6.8	6.4	9.1	9.1

It will be seen from Table 4 that the spread in the yields between the sugar beets grown on the manured alfalfa and sweet-clover land and those grown in the other rotations, which are here used as a check, is increasing with time. This difference is due largely to a decreased yield from the check rotation rather than to an increase from the manured alfalfa and sweet-clover rotations. The average acre yield of all check rotations for the first three-year period was 16.4 tons, for the second period 11.3 tons, for the third period 8.1 tons, for the fourth period 10.3 tons, and for 1925, 12.1 tons. Some of this variation is due to the difference in the seasons, but most of the difference between the first and the fourth period is due very largely to the decreased production of the land. The seasonal conditions were somewhat similar for the two periods, as will be seen by the yields from the manured plots.

The extra yield of sugar beets resulting from the application of manure averaged 4.3 tons per acre for the first period and 8.9 tons for the last three-year period. The 13-year average was 6.8 tons.

During the last four years the increased yield due to manure was 0.75 ton of sugar beets for each ton of manure applied. If each additional ton of sugar beets has a net value of $4.50, the manure increased the net money returns by $3.37 for each ton of manure applied. With sugar beets at $7 net per ton, the manure would return a value of $5.25 per ton. When a farmer fails to take into account the value of the manure produced in his feeding operations he is overlooking a very important item. (Fig. 1.)

The increased acre yield of sugar beets due to the residual effect of the alfalfa averaged 5.2 tons for the second three-year period and 7.8 tons for the last three-year period. The 10-year average was

FIG. 1.—Sugar beets grown on manured land in rotation 31. Every ton of manure applied to these rotations increased the yield of sugar beets 0.75 ton. With sugar beets at $5 a ton, the manure has a value of $3.75 a ton. Scotts Bluff Field Station

6.4 tons. As the result of the residual effect of alfalfa, even during the second and third seasons after it was plowed up, there was a net increase of $34.42 per acre when the extra yield of beets was worth $4.50 net per ton. With a higher value for sugar beets the net returns resulting from this residual effect would be proportionately higher. During this last period alfalfa similar to that which was plowed up yielded about 5 tons. With the prices of sugar beets and hay that usually prevail, the net return from the residual effect of alfalfa is practically as great as the total gross return from the hay crop. This being true, one can well afford to grow alfalfa even though the hay crop does not show much of a profit.

In experiments in which manure is applied to sugar beets in rotations, including alfalfa, the increase in yield due to the manure is much less than it is in the rotations which do not have alfalfa. Using the average of the past four years, the sugar beets grown in rotations without either manure or alfalfa yielded 10.8 tons; those in the

manured rotation, 19.8 tons; those in unmanured alfalfa rotations, 18.4 tons; and those in rotations in which both alfalfa and manure were used, 21.4 tons per acre. Manure was applied at the rate of 12 tons per acre. Each ton of manure used in the no-alfalfa rotations increased the yield of sugar beets 0.75 ton, while the same amount applied to the alfalfa rotations increased the yield only 0.25 ton, or one-third as much. Manure is far more essential on a farm where neither alfalfa nor sweet clover is grown than it is where either is used in the cropping system.

Growing either alfalfa or sweet clover on run-down land will bring it back to a state of profitable production. When the sweet clover is pastured during the second summer, it seems to have about the same fertilizing value as four years of alfalfa when the alfalfa is harvested for hay. Sweet clover has the advantage of fitting into short rotations, as it occupies the land only one year. A six-year rotation in which alfalfa is used and a four-year rotation where sweet clover is pastured by sheep were begun in the spring of 1920 on land rather badly run down. The acre yields from the plots before they were seeded to alfalfa or sweet clover averaged 224 bushels of potatoes and 11.8 tons of sugar beets in the alfalfa rotation, and 11.8 tons of sugar beets in the sweet-clover rotation. Since these cultivated crops have come on the alfalfa or sweet-clover land, the potatoes have averaged 331 bushels and the sugar beets 19.6 tons per acre in the alfalfa rotation, and the sugar beets in the sweet-clover rotation have averaged 21.1 tons the first year and 18.4 tons the second year, following pastured sweet clover. This shows an increase of 107 bushels of potatoes and 7.8 tons of sugar beets due to alfalfa; and 9.3 tons of sugar beets the first year, and 6.6 tons the second year due to pasturing sweet clover on the land.

Poor run-down land will respond to the beneficial effect of manure, alfalfa, and sweet clover with a greater increase in yield than will good productive land. That is, it is easier to improve run-down land so that it will produce as much as 6 tons per acre more sugar beets than it is to increase the productiveness of good land to this same quantity. Where the applications of manure, the growing of alfalfa, or the pasturing of sweet clover on poor run-down land would increase its productiveness by 6 or 8 tons per acre, the same treatment applied to good productive land probably would not increase its productiveness to more than one-half these quantities. The good land, however, would still produce a higher total yield. In the same manner, a heavy application of manure will not increase the yield, in proportion to the quantity of manure, as a lighter application will. Sixty tons of manure will produce a much greater increase when applied to 5 acres than if it is all applied to 1 acre.

The necessity of high acre yields of such crops as sugar beets, the expense of growing which is very high and the cost of which is practically the same whether the yield is high or low, is very important if a profit is to be realized. It is generally conceded that it requires approximately a 10-ton yield of sugar beets to pay the acre cost of production. With yields less than 10 tons per acre there is a financial loss, while a yield over and above 10 tons per acre is all net profit except the cost of hauling the extra yield. On this basis a 12-ton yield is twice as profitable as an 11-ton yield, and a 20-ton yield is five times as profitable as a 12-ton yield. For the last four years the

average acre yield from the check rotations is 10.8 tons, or 0.8 ton profit; while the average from the manured, alfalfa, and sweet-clover rotations is 19.2 tons, or 9.2 tons profit. Twenty-two acres of sugar beets yielding 19.2 tons per acre will give the same net profit as 253 acres yielding 10.8 tons per acre. It is not the total yield that counts, but it is the extra yield above the cost of production that makes the profit.

POTATOES

In the crop-rotation experiments there are 15 plots of potatoes grown in as many different cropping systems. On one plot potatoes are grown continuously. Potatoes are also grown in six 2-year, two 3-year, two 4-year, three 6-year rotations and one 7-year rotation. Two of the 2-year and one each of the 3-year, 6-year, and 7-year rotations receive manure at the rate of 12 tons per acre. In the 2-year rotations potatoes follow manure the first year; in the 3-year rotations they follow manure the second year; and in the 6-year and 7-year rotations they follow manure the fifth year. In all of the alfalfa rotations potatoes follow the alfalfa; potatoes also follow corn, oats, and sugar beets. Thirteen of these cropping systems were begun in 1912 and the other two, a 6-year and a 7-year rotation, in 1920. The same kind of seed is used for all plots and each receives the same cultural treatment. Any difference in yield is therefore due chiefly to the effect of the preceding crop or of the manure.

In 1913, which was the second year of the experiment, the yields of the potatoes following sugar beets were consistently much higher than those following either corn or oats; but this difference soon disappeared, and there has been little difference in the later yields of potatoes following either sugar beets, corn, or oats. (Fig. 2.) Some farmers have the notion that it improves the land for potatoes to grow sugar beets on it, and likewise that it improves the land for sugar beets to grow potatoes on it. This is true only when the land is good to begin with. It is impossible to put worn-out land in good condition for potatoes by growing sugar beets on it, or to make it more productive for sugar beets by growing potatoes on it. The only crops that seem to have a beneficial effect on the yield of potatoes are the legume crops, such as alfalfa and sweet clover.

The beneficial effect of alfalfa on the yield of potatoes is very marked, much more so than that of manure, although of late the indications are that as time goes on the good effect from the manure will increase. In 1925 for the first time the highest yielding manured plot produced more potatoes than did the lowest yielding plot on alfalfa land. In rotations in which potatoes follow three years of alfalfa in the six-year and seven-year rotations, the yield is usually higher than in rotations in which they follow two years of alfalfa in the four-year rotation. If a farmer has both manure and alfalfa land, and if he is growing both sugar beets and potatoes, he should put sugar beets on the manured land and potatoes on the alfalfa land.

The main differences in the potato yields from these different cropping systems are due largely to the fact that the yields from the rotations not receiving manure or alfalfa have decreased, those from the manured rotations remaining about the same, while those following alfalfa have increased. The seasonal variation is rather large,

but the differences between the plots receiving their respective treatments remain rather constant year after year, with a tendency to widen rather than to become less. The acre yields in 1922 were about normal, the average for all plots being 234 bushels; the 1923 yield, 115 bushels, was far below normal; while the yields for 1924 and 1925, averaging 297 and 332 bushels, respectively, were the highest in the history of the experiment. The effects of manure and of alfalfa on the yield of potatoes are shown in Table 5, which gives a summary by three-year periods since 1913.

FIG. 2.—Potatoes in rotation 40. The yields of potatoes and sugar beets in this rotation have been maintained or increased during a period of 14 years by the aid of alfalfa in the cropping system. Scotts Bluff Field Station

TABLE 5.—*Summary by three-year periods and for 1925 of the yields of potatoes from irrigated rotations, showing effect of manure and alfalfa, Scotts Bluff Field Station, 1913–1925*

Period	Average acre yield (bushels) from—				
	No manure, 5 plots	Manure, 3 plots	Alfalfa, 6 plots	Increase in favor of—	
				Manure	Alfalfa
1913–1915	172	247	297	75	125
1916–1918	142	172	275	30	133
1919–1921	119	188	271	69	152
1922–1924	131	228	287	97	156
1925	208	386	409	178	201
Average	146	222	292	76	146

As shown in Table 5, the three-year average acre yields in favor of the manured rotations have ranged from 30 bushels in the second period to 97 bushels for the fourth and 178 bushels for 1925, the 13-year average being 76 bushels; while the difference in favor of alfalfa has ranged from 125 bushels in the first period to 156 bushels for the last three-year period and 201 bushels for 1925, the average for the 13 years being 146 bushels. During the last four years the average acre yield has been 150 bushels in rotations without manure or alfalfa; 268 bushels in the manured rotations; and 317 bushels for those following alfalfa. Assuming that it requires an acre yield of 125 bushels to cover cost of production, the potatoes grown in rotations without manure or alfalfa show a profit of 25 bushels, those from manured rotations a profit of 143 bushels, and those from alfalfa rotations a profit of 192 bushels. On this basis it will require 1.35 acres of manured land or 7.68 acres of land on which neither manure is applied or alfalfa grown, to produce as many bushels of profit as 1 acre of alfalfa land. The foregoing figures are based on yields only; the quality of the potatoes as affected by the cropping system is not considered.

The cropping system has a marked effect not only upon the yield but also upon the quality of the potatoes. In the short rotations, scab soon became rather prevalent and increased rapidly with each crop until the potatoes became unmarketable. Since about the second cycle the potatoes grown in the continuously cropped plot and in the two-year and three-year rotations have, with one exception, been so scabby that they were unmarketable, notwithstanding the fact that clean treated seed is used each year. The potatoes grown in the four-year rotations have much less scab than those in the three-year rotations, while those grown in the six-year and seven-year rotations are usually rather free from scab. The potatoes from the short rotations in 1925 were very much freer from scab than those of previous years. A large part of this crop was graded U. S. No. 2. The climatic conditions evidently were unfavorable for scab development.

There is no doubt that the scab disease lives in the soil at least two years and to a slighter degree for three years, but it seems to die out before the fifth year. Although it is true that there is occasionally some scab on the potatoes grown in the six-year and seven-year rotations, the same is true of potatoes grown on new lands. It is possible that this scab germ is carried by wind or irrigation water to new land, where if climatic conditions are favorable, scab develops. The amount of scab from this source is usually very small compared with the amount that lives over in the soil from one potato crop to the other in short rotations. The effect of the rotation on yield and quality is shown in the profit-and-loss chart in Figure 9.

It is evident from the results of 14 years of experiment with these different cropping systems that a farmer, in order to keep the scab down to a minimum, must plan his rotations so that potatoes will not come on the same land oftener than once in five or six years. An ideal rotation for potatoes is one in which potatoes follow three or four years of alfalfa, with enough other crops included to make a six or seven year rotation. It is sometimes permissible to follow

alfalfa with two crops of potatoes, provided there is little or no scab present on the tubers from the first crop.

There are two factors which go to make potato growing profitable—the price per unit of production and the yield. It is not the total production but the acre yield of marketable potatoes above the acre cost of growing and marketing the crop that makes profit. It is possible to cut down the total production, which will stimulate higher prices, and still produce as many profit bushels as from the higher total quantity. Where an acre yield of 125 bushels of potatoes is required to cover the acre cost of production, a yield of 150 bushels will return 25 bushels profit, while a 300-bushel yield will give a profit of 175 bushels. A 300-bushel yield, therefore, is seven times as profitable as a 150-bushel yield. It will require 70 acres yielding 150 bushels per acre to give the same number of profit bushels as 10 acres yielding 300 bushels per acre. The 70 acres will produce a

FIG. 3.—Corn following alfalfa in rotation 62. The average acre yield of this plot during the last 9 years has been 61 bushels, as compared with 35 bushels from rotation 32, where alfalfa is not grown in the rotation. Scotts Bluff Field Station

total of 10,500 bushels, while the 10 acres will probably produce only 3,000 bushels. Both fields produce the same number of profit bushels, but in order to do so the 70 acres produce 250 per cent more potatoes than the 10 acres, or 7,500 bushels more, and it is this 7,500 bushels which yield no profit that help to create an overproduction and low prices.

CORN

Six corn plots are grown in as many different cropping systems. One is continuously cropped, two are two-year rotations, one is a three-year rotation, and two are six-year rotations. The corn in the six-year rotation follows alfalfa, in the three-year rotation it follows sugar beets, and in the two-year rotation it follows both potatoes and oats. In one of the six-year rotations the corn is harvested by hogs. A local variety of dent corn is used. (Fig. 3.)

During the first three-year period the corn grown in the rotation without alfalfa yielded well, only 10 bushels per acre less than for the plot following alfalfa. This yield, however, decreased until the yield for the fourth period was only 40 per cent as much as that from the alfalfa rotation and less than one-half as much as for the first period. A summary of three-year averages and for the year 1925, showing the effect of alfalfa in maintaining the yield of corn, is given in Table 6.

TABLE 6.—*Summary by three-year periods and for 1925 of yields of corn from irrigated rotations, showing effect of alfalfa, Scotts Bluff Field Station, 1912–1925, omitting 1915*

Period	Average acre yield (bushels)		
	No alfalfa or manure plots	Alfalfa plots	In favor of alfalfa
1912–1914	61	71	10
1916–1918	42	59	17
1919–1921	29	48	19
1922–1924	27	69	42
1925	40	75	35
Average	40	63	23

As will be seen from Table 6, this increased yield of 10 bushels per acre for the first period, due to the effect of alfalfa, has increased each three-year period until the difference during the fourth period amounted to 42 bushels per acre. Assuming that it requires 35 bushels of corn to pay the acre cost of production, and using the average yield for the last four years, the corn grown in the rotations not including alfalfa shows a financial loss of some 5 bushels per acre, while the corn following alfalfa shows a net profit of more than 35 bushels.

For some unknown reason corn does not do well when following sugar beets. As soon as it comes up it takes on a pale, sickly appearance, grows more slowly, and is later in maturing. The yield is about the same as when following either potatoes or oats.

OATS AND WHEAT

Twenty-one plots of oats and six of wheat are grown in these crop rotations. Neither of these grains is a profitable crop to grow on irrigated land in the North Platte Valley. Barley should be used instead. A grain crop should not be grown on this irrigated land as a common practice except when it is to be seeded down to alfalfa or sweet clover. In these rotations oats are grown in 3 manured and 10 alfalfa or sweet-clover rotations, while the other 8 plots are in rotations where neither manure, alfalfa, nor sweet clover is used. The average acre yield of oats for the last nine years in rotations without manure, alfalfa, or sweet clover was 45 bushels; in the manured rotations, 67 bushels; and in the alfalfa or sweet-clover rotations, 69 bushels. Wheat yielded 17 bushels in rotations without alfalfa and 27 bushels in alfalfa rotations.

CASH RETURNS FOR THE VARIOUS CROPS

When the returns from the different crops are expressed in dollars and cents, the effect of the rotation is even more apparent. The items taken into consideration in computing the returns from these different crops and rotations and the amounts charged to each item are as follows: Interest and depreciation of farm equipment, together with taxes and water charges, $10 an acre; man and team, $5 a day; alfalfa hay, $6 a ton; sugar beets, $5 a ton; No. 1 potatoes, 50 cents a bushel; cull potatoes, 15 cents a bushel; corn, 60 cents a bushel; oats, 35 cents a bushel; wheat, 70 cents a bushel. No charge is made for the manure except for the cost of hauling and spreading it on the land. It is not intended by the use of these prices to convey the idea that this is a cost-of-production discussion, but rather to compare the different cropping systems in terms of the dollar, as that is more understandable to the average person than bushels and tons.

On the basis of these prices and the nine-year average yields, potatoes show both the greatest loss and the highest profit. On an acre basis, potatoes grown on the same land year after year show a loss of more than $42, whereas the potatoes grown on alfalfa land in the six-year and seven-year rotations show a net profit of $70. The average loss from all the potato plots grown in the short rotations, three years or less, amounts to more than $37 an acre, while those grown on alfalfa land in the longer rotations yield a net profit of more than $64. Sugar beets grown in rotations not having alfalfa or sweet clover nor receiving manure show a small profit, but when grown in rotations having either of these legumes or receiving manure they return a net profit of between $25 and $50 an acre. Returns from corn vary from a small loss in the poor rotations to a net profit of $12 an acre when grown on alfalfa land. Small grain shows a loss from the poor rotations and only a small profit from the good ones.

These 34 different cropping systems might well be divided into two classes—poor rotations and good rotations. The poor rotations are short and do not contain either alfalfa or sweet clover, while the good rotations are longer and keep about one-half of the land in alfalfa or sweet clover.

The profit or loss per acre of each crop in 13 of these cropping systems is shown graphically in Figure 4. The profit or loss is also given at the botton of the column for the whole cropping system, figured on the basis of an 80-acre farm in which 77 acres are cropped, the charge against each item being the same as those mentioned on a previous page. The yields used are nine-year averages, with the exception of rotations 45, 64, and 71, in which four-year averages are used, these rotations having been started in 1920.

The number of each rotation is given and appears just above the column. Rotations with numbers less than 10 are 1-crop systems; those with numbers between 10 and 29 are 2-year rotations; those in the 30's are 3-year rotations; this alignment obtaining up to and including the 70's, which are 7-year rotations. The odd-numbered rotations receive manure at the rate of 12 tons per acre, while the even-numbered rotations do not receive any manure. In experiments in which the rotation period is four years or longer, alfalfa or sweet clover is used in the cropping system.

The crops appearing below the base line of the chart show a financial loss, and those above the base line show a profit. The profit or loss from the different cropping systems, when figured on the basis of an 80-acre farm, ranges from a loss of $3,234 in No. 4 system, which is continuous potatoes, to a net profit of $1,827 in No. 71 system, in which there are 11 acres of oats seeded with alfalfa, 33 acres of alfalfa, 11 acres of potatoes, and 22 acres of sugar beets.

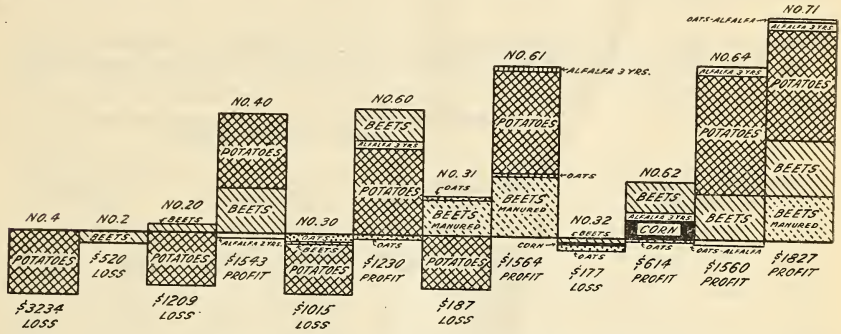

FIG. 4.—Profit or loss per acre of crops grown in different cropping systems, with the total profit or loss from an 80-acre farm. Scotts Bluff Field Station

EXPERIMENTS WITH SUGAR BEETS

RESIDUAL VALUE OF MANURE ON YIELD

In a fertilizing test which was begun in 1917, different quantities of barnyard manure were used in the growing of sugar beets. There are 21 plots, which consist of 6 sets of plots in triplicate and 1 set of 3 control plots which received no manurial treatment. Five sets of plots during the first year received manure at the rate of 12, 24, 36, 48, and 60 tons per acre, respectively. In 1918 manure was again applied at the same rate to one plot, and 1919 to two plots (including that manured in 1918), in each of the five sets manured in 1917. In each set, then, one plot received three applications, one received two applications, and one received one application of manure. No additional manure has been applied since the spring of 1919.

Sugar beets were grown on these plots each year from 1917 to 1925, inclusive. The stand in 1919 was very uneven, and the yields for that year are not reported. During the early part of this experiment the plots receiving manure showed a marked increase in yield, but not in proportion to the quantity of manure used. The light applications showed a greater increase of yield per ton of manure than did the heavier applications. In 1917 a 12-ton application increased the acre yield of sugar beets 3.1 tons, as against an increase of 4.1 tons for plots to which manure was applied at the rate of 60 tons per acre. Had the 60 tons of manure been applied to 5 acres instead of to 1, the increase in yield of sugar beets due to this same quantity of manure would have been 15.5 tons instead of 4.1 tons. On the other hand, the yields obtained during the period 1921 to 1925, inclusive, from those plots which have not received manure since the spring of 1919, show that the residual effect is much greater from the heavy applications than from the light applications.

In order to show the immediate and residual effects of different quantities of manure, the results are divided into two periods. The yields in 1917, 1918, and 1920 show the immediate effect and those of 1921 to 1925, inclusive, the residual effect. The average acre yield of the three plots which received no manure was 15.1 tons during the first period and 12.5 tons for the second period. The increase in yields due to the direct effect and to the residual effect of manure are given in Table 7.

TABLE 7.—*Direct and residual effects of different quantities of manure on yield of sugar beets, Scotts Bluff Field Station, in 1917, 1918, 1920, and 1921–1925*

Quantity of manure in each application	Increased acre yield due to direct and to residual effects of different quantities of manure					
	Three applications—in 1917, 1918, 1919		Two applications—in 1917 and 1919		One application—in 1917	
	Direct effect	Residual effect	Direct effect	Residual effect	Direct effect	Residual effect [1]
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
12 tons	1.9	0.7	3.5	1.5	2.0	−0.2
24 tons	5.1	3.1	3.6	2.3	2.4	−1.0
36 tons	4.5	3.1	4.2	1.8	2.4	−.9
48 tons	5.9	3.6	4.1	2.1	2.2	−.9
60 tons	6.6	6.0	5.3	3.8	2.4	0
Average increase during period	4.8	3.3	4.1	2.3	2.3	−.6

[1] Minus sign indicates decrease.

As will be seen from Table 7, the acre yield of sugar beets increased with the quantity of manure applied and decreased with the number of years following the application. While the lasting effect may not be in direct proportion to the quantity of manure applied, it is in that direction. Manure put on the land in 1917 seems to have lost all of its residual effect, while that applied in 1918 and 1919 still shows considerable influence on the yield. In cases where the same number of applications were made, the increase due to the residual effect of the manure is, more or less, in proportion to the quantity used.

The total value of manure in actual farm practice is not used up by the first crop. Just how many crops will be benefited will depend upon the quantity put on the land. This is a practical problem in tenant farming.

TIME OF PLANTING SUGAR BEETS

Sugar beets should be planted early and the seeding done soon after the land is prepared. This is more important when the spring is dry than when there is considerable rainfall. The sugar-beet seedling being small, the seed must be planted shallow, and it requires considerable moisture for germination. If planted early while the weather is yet cool and evaporation is low, it has a better opportunity to get the necessary amount of moisture for germination than it has later when evaporation is high. If the land is plowed and prepared long in advance of planting, weeds get a good start before the sugar beets are planted and cause trouble and damage at thinning time; but if beet seeds are planted in freshly prepared soil they receive the

advantage of the surface moisture. If a large acreage is to be planted, it is advisable to prepare 10 or 12 acres and plant them immediately, then to prepare 10 or 12 acres more, planting this amount at once, and continuing this method until the whole field is planted, rather than to prepare it all before beginning to plant. Another reason why the whole of a large beet field should not be planted at the same time is that the beets will all be ready to thin at the same time, and if the thinning is delayed two or three weeks the yield will be materially reduced. An average of three years' tests shows that when thinning was delayed 20 days the yield was reduced more than 5 tons per acre. The results from tests conducted during the summers of 1920 and 1922, showing the effect upon yield of delayed planting after the preparation of the land, are given in Table 8.

In experiments in which sugar beets were planted on the land four weeks after it was prepared, the acre yield was 6.3 tons less than in experiments in which the planting was done the next day after the land was prepared. This reduction in yield is due largely to the damage caused by weeds and to poor germination of late plantings. The results of this test and of another time-of-planting test conducted in 1925 show that, other things being equal, sugar beets planted between April 15 and May 2 yielded 17.1 tons per acre as compared with 10.3 tons from those planted between May 15 and May 30.

TABLE 8.—*Effect of delayed planting after land is plowed and seed bed prepared, on yield of sugar beets, at the Scotts Bluff Field Station in 1920 and 1922*

Time of planting	Acre yield	Time of planting	Acre yield
	Tons		*Tons*
Four weeks after plowing	8.3	Two weeks after plowing	12.1
Three weeks after plowing	10.8	Next day after plowing	14.6

PLOWING COMPARED WITH DISKING FOR SUGAR BEETS

Conditions may arise under which the speeding up of the land preparation for the sugar-beet crop would be advantageous. There may be an unduly large acreage, or April may be so cold and wet that field work is delayed. Under such conditions it may be advisable to disk rather than plow the land which was in either sugar beets or potatoes the previous year. As the harvesting of either sugar beets or potatoes gives the soil a good stirring in the fall, there is a question whether plowing in the spring is really necessary.

If toward the latter part of April or later a considerable part of the sugar-beet land remains to be prepared, it may be possible to plant the crop a week or 10 days earlier, by using the disk instead of the plow. The most serious objection to the use of the disk is that on disked land the weeds are always more troublesome than on land plowed in the spring. However, weeds are no more troublesome on disked land than on fall-plowed land. Disked potato land also, especially if it is disked when the soil is somewhat dry, may blow more than if it were plowed. To get the comparative yield of sugar beets when grown on plowed land and on disked land, tests were conducted during the summer periods 1920 to 1923, inclusive, and also in 1924 and 1925. The three-year test was made on sugar-beet

land and the two-year test on potato land. The respective results are recorded in Table 9.

TABLE 9.—*Yield of sugar beets when grown on plowed and disked beet and potato land at the Scotts Bluff Field Station, in stated years*

Character of preparation	Acre yield of sugar beets (tons) grown on—						
	Beet land				Potato land		
	1920	1921	1922	3-year average	1924	1925	2-year average
Plowed land	10.3	15.2	13.6	13.0	19.2	20.0	19.60
Disked land	9.2	15.0	13.1	12.4	18.0	19.7	18.85
Increase from plowing	1.1	.2	.5	.6	1.2	.3	.75

In each test, as shown in Table 9, sugar beets grown on plowed land yielded more than those on disked land. On old beet land this difference varied from 1.1 tons to 0.2 ton, and the average for the three years was 0.6 ton. On the potato land the difference was 1.2 tons in 1924 and 0.3 ton in 1925, the two-year average being 0.75 ton. The total average of the two tests, which represents 20 plowed plots and 20 disked plots, shows 0.66 ton per acre in favor of plowing. Perhaps the weed factor is responsible for a large part of this difference, for weeds were more numerous on the disked plots. If by disking the crop can be planted a week or 10 days earlier, the advantage thus gained will more than make up for the difference in favor of plowing.

The differences in yields between the sugar beets grown on beet land, and those grown on potato land are due largely to seasonal variation rather than to the land factor.

IRRIGATION OF SUGAR BEETS

There was an erroneous notion, held by some farmers on irrigated land, that a crop should not be irrigated until it reaches a certain stage of growth or until a certain calendar date. The object of irrigation is to supplement the rainfall. When the time and the amount of rainfall vary, irrigation likewise should vary. Speaking generally, any crop should be irrigated when it needs water, regardless of the stage of growth or the time of season. It is sometimes necessary to irrigate such crops as sugar beets and potatoes to get them through the soil. The only objection to this is the difficulty of applying water, as flooding should be avoided.

In the spring of 1925 a test was begun to discover the effect of early and delayed irrigation of sugar beets. The sugar beets were planted April 24, and, as it was very dry the latter part of April and the first week of May, they were irrigated May 4 before they had come up. The whole field was treated alike until July 8, when it was divided into four sets of plots and water was applied to one set. The other sets of plots were irrigated for the first time July 20, August 1, and August 10, respectively. Those irrigated July 8 were again irrigated July 20, August 1, 10, and 24. Following the first application,

each succeeding irrigation was the same for all plots. The results from this one year's test are given in Table 10.

TABLE 10.—*Effect of early and delayed irrigation on yield of sugar beets at the Scotts Bluff Field Station, 1925*

Date of first irrigation	Acre yield	Date of first irrigation	Acre yield
	Tons		*Tons*
July 8	24.2	August 1	20.7
July 20	21.3	August 12	18.5

Plots on which irrigation began as early as July 8 yielded 24.2 tons per acre as compared with 18.5 tons on plots from which water was withheld until August 12. The spread perhaps would have been greater had it not been for the favorable growing weather during September and the first week in October. In each case the earlier the irrigation began the higher was the yield.

EXPERIMENTS WITH POTATOES

SPINDLE-TUBER DISEASE

At one time it was thought that irrigation water was the cause of "running out" in potatoes. Later experimental data have shown that this degeneration of potatoes is due to a potato disease known as spindle tuber and is not caused by irrigation. It does appear, however, that this disease spreads more rapidly under irrigation conditions than on dry land. Just how the disease is spread or by what means is not known.

In 1923 a test was begun to determine whether spindle disease is carried by irrigation water from diseased plants to healthy ones and to what extent the disease spreads across rows. A field some 400 feet long was used. Six rows the full length of the field were planted with certified seed, and all tubers showing spindle-tuber characteristics were removed; four rows one-third the length of the field were planted with spindle-tuber potatoes, and the remainder of these rows were planted with the same certified seed as was used in planting the first six rows. This planting was made in quadruplicate. The experimental plots were so arranged that when irrigation water was applied the water first passed by and came in contact with the spindle-tuber plants and then passed down to the healthy plants which made up two-thirds of the lower ends of the rows.

At harvest time three samples were taken from each row to be used as seed the following year. One sample was taken from the upper end of the field where the spindle-tuber potatoes were planted, one sample from the middle of the row, and another from the lower end. In 1924 these samples from the quadruple plots were made into a composite lot and 10 of them were planted in rows about 300 feet long. A seed sample was again saved from each row planted in 1924, and in the spring of 1925 three samples were planted in rows more than 300 feet long.

The 1924 and 1925 yields from these different lots, in bushels per acre, are recorded in Table 11.

TABLE 11.—*Yields of potatoes at the Scotts Bluff Field Station in 1924 and 1925, showing the extent to which the spindle-tuber disease spread during the growing season of 1923 in potatoes grown adjacent to spindle-tuber stock*

Year	Acre yields (bushels)									
	Run outs from run outs	Normal from run outs	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Middle row	Control rows
1924	129	198	238	308	356	352	316	296	463	466
1925	92	21	73	154	108	154	148	138	306	290

"Run outs from run outs," as the term is used in the table, were spindle tubers from the 1923 spindle-tuber stock; normals from run outs were normal-looking potatoes grown from the 1923 spindle-tuber stock; rows 1, 2, 3, 4, 5, and 6 were all from 1923 certified seed stock, but this stock was grown between four rows on either side of spindle-tuber stock in 1923, rows 1, 2, and 3 being nearest the spindle-tuber rows on the north and rows 6, 5, and 4 being nearest the spindle-tubers on the south; the stock of the middle rows was from certified seed and was grown in 1923 in the spindle-tuber certified row, where the irrigation water first passed through the spindle-tuber rows; the check rows were also from the 1923 certified seed and were grown more than 100 feet from the spindle-tuber stock.

As is shown in the table, run outs and normal tubers from run outs produced very low yields when compared with the control rows. In 1925 the normal-looking potatoes picked from run-out stock yielded less than those showing run-out characteristics. The seed used for the other plots was all 1923 certified stock and had been grown under the same cultural conditions but under different conditions with reference to the spindle-tuber plot in 1923. The seed used in 1924 from the certified stock showed no signs of spindle tuber, whereas that used in 1925 from rows 1 to 6, inclusive, showed considerable spindle tuber.

By comparing the yields of each of the six rows with that of the check row it will be seen that the yield of each was low in 1924 and still lower in 1925. In general, the nearer the seed was grown to the spindle-tuber plots in 1923 the less it produced in the two succeeding years. The middle row, from certified seed grown at the lower end of the spindle-tuber rows in 1923, showed no signs of spindle tuber and yielded about the same as the control plot.

From these data it seems certain that the spindle-tuber disease spreads across at least three rows, but is not carried from diseased plants to healthy plants down the row by irrigation water.

POTATOES FOR EARLY MARKET

While the main crop of potatoes grown in the North Platte Valley is for the late fall or winter market, a small acreage is grown to supply a somewhat earlier market. Often the price of potatoes is considerably higher about the first week in September than it is a month or six weeks later. In order to supply this market potatoes must be planted about May 1, and a variety that produces good-sized pota-

toes early should be used. It is with this market in mind that a time-of-digging test was conducted with both Red Triumph and Irish Cobbler varieties in 1922 and 1925. The potatoes were planted during the second week in May, and digging began August 1 in 1925 and August 8 in 1922. In each plot there were four rows 300 feet long. The date of each digging, together with the acre yields, is given in Table 12.

TABLE 12.—*Yields of Red Triumph and Irish Cobbler potatoes dug at different dates, Scotts Bluff Field Station, 1922 and 1925*

Date of digging	Acre yield (bushels)						
	Triumph			Irish Cobbler			Difference in favor of Irish Cobbler
	1922	1925	2-year average	1922	1925	2-year average	
Aug. 1	----------	153	----------	----------	236	----------	83
Aug. 8	183	199	191	209	274	242	51
Aug. 17	226	264	245	227	302	265	20
Aug. 28	241	314	278	282	352	317	39
Sept. 6	270	307	288	279	336	307	19
Sept. 19	247	302	275	308	323	315	40
Sept. 28	250	305	277	287	341	314	37

The yield each year was higher with each delayed digging until about the 1st of September, when the yields were about the same. Early blight developed on these potatoes each year about the last of August and perhaps stopped further growth. Had it not been for this damage from early blight doubtless the Triumphs would have outyielded the Cobblers in the later diggings.

Quality in the potatoes varied, those dug early being much better than those dug late. The Cobblers were especially good in both size and quality until about the 1st of September, when scab began to develop and became very bad on those dug late. The Triumphs were not so good, even from the early diggings. They were small in size and more or less scabby and damaged by growth cracks. The damage from these causes became worse as the season advanced.

These two tests show that the Cobbler is a better potato to grow for the early market. The results also show that when potatoes are planted early they should be dug early; otherwise they are very apt to become badly damaged by scab, which seems to develop during the latter part of the growing season on potatoes somewhat nearer the stage of maturity.

TIME-OF-PLANTING POTATOES TEST

The proper date to plant potatoes varies with the season. Generally speaking, potatoes are planted in the North Platte Valley too early rather than too late for the highest production of marketable potatoes. Potatoes planted as early as the middle of May are far more susceptible to scab, growth cracks, and early blight than those planted after the 1st of June. In years when early blight is bad, potatoes planted after June 10 are seldom damaged, whereas those planted before June 1 are damaged badly. Barring early blight, potatoes planted about the middle of May will produce a

higher total yield than those planted a month later, but usually there is a much higher percentage of culls in the early plantings, so that the marketable potatoes are in favor of the later plantings.

A time-of-planting test with potatoes was conducted during 1924 and 1925. The yields in bushels per acre and the dates of the plantings are given in Table 13.

TABLE 13.—*Yields of potatoes planted at different dates, Scotts Bluff Field Station, 1924 and 1925*

Date of planting	Acre yield (bushels)		Date of planting	Acre yield (bushels)	
	1924	1925		1924	1925
May 7		308	June 16	421	215
May 19		325	June 25	345	148
May 27	475		July 7	325	63
June 5	437	295	July 20	165	

In 1924 planting began May 27 and ended July 20; in 1925 it began May 7 and the last planting was made July 21. With one exception the yields each year decreased with each subsequent planting. In general, the yields were much higher in 1924 than in 1925, and the quality of potatoes in 1924 was very good for all plantings. At least 40 per cent of the potatoes from the plantings made on May 7 and 17 in 1925 were badly damaged by scab and growth cracks, while those from the later plantings were free from scab. The same kind of seed, after being treated with corrosive sublimate, was used for each planting.

EXPERIMENTS IN CROP UTILIZATION WITH LIVESTOCK

ALFALFA PASTURE FOR HOGS

Hogs harvested the third-year alfalfa plot in one of the series of irrigated rotations. The alfalfa in this rotation is seeded in oat stubble in the fall. The returns from the pasture were rather low for the season of 1925, especially for the first period, when fall-farrowed shotes were used to harvest it. During the second period spring-farrowed pigs were used and the returns were greater.

The plot covers a quarter of an acre and is divided into two parts, which are grazed alternately. The hogs are fed a 2 per cent ration of corn while on pasture. The results for 1925 compared with a 12-year average, all figured to the basis of 1 acre, are shown in Table 14.

Figuring the value of gains in weight made by the hogs at $7 per hundredweight, and of the corn fed at 60 cents per bushel, the net return per acre of alfalfa pasture is $28.89 for the first period and $80.84 for the second, or a total of $109.73 for the season. On the same basis, the average net return for 12 years is $125.67 per acre. The average yield of all the alfalfa in the rotations was 3.9 tons per acre. On this basis the hogs paid $28.13 per ton for the 1925 hay crop. The average yield of the three-year alfalfa plots for a period of nine years is 6.28 tons per acre. At this rate the hogs returned annually a value of $20.03 per ton for the alfalfa. The average pork produced per acre for the 12-year period was 2,975 pounds. It required 262

pounds of corn in addition to the alfalfa to produce 100 pounds of pork.

TABLE 14.—*Results of pasturing alfalfa with hogs at the Scotts Bluff Field Station in 1925 compared with the average for the 12-year period 1913–1924*

Items of comparison	Season of 1925			12-year average
	Spring period	Summer period	Total	
Number of hogs on pasture per acre	20	36		
Total initial weight ... pounds	2,320	2,140		
Total gains made ... do	960	2,020	2,980	2,975
Total corn fed ... do	3,580	5,660	9,240	7,718
Corn fed per pound of gain ... do	3.73	2.80	3.10	2.62
Financial statement:				
Net returns from pasture per acre	$28.89	$80.84	$109.73	$125.67
Cost per 100 pounds of gain (pasture at $15; corn $1.07 per 100 pounds)	4.72	3.40	3.82	3.32

LAMB-FEEDING EXPERIMENTS

Lamb-feeding experiments have been conducted for the purpose of gathering information on the feeding value of home-grown feeds, especially the by-products of the sugar-beet industry, and to find out how these feeds can be combined with feeds shipped in so as to yield the highest return from the feeding operation. Lamb feeding fits in well with the type of farming followed by many farmers in the North Platte Valley. This is a type of farming in which the principal object sought is the production of large yields of potatoes and sugar beets. Alfalfa is usually grown in such a cropping system not so much for the crop itself as for the beneficial effect that it has on the crop planted after the alfalfa is plowed up. This type of farming requires a maximum of labor during the summer months, and leaves little or nothing to do during the winter. As lambs are usually put into the feed lot after most of the fall work is completed and are shipped to market before spring work beings, farmers who are financially able to stand the losses of the bad years find that lamb feeding is profitable, that it furnishes a good market for the roughage, such as alfalfa and beet tops, and that it also produces manure on the farm, which aids materially in keeping up the yields of the other crops.

The tests herein reported were begun in the fall of 1922 and continued for three consecutive winters. There were 13 lots, with 30 lambs in each lot the first winter and 25 the second and third winters. In this experiment there are three principal comparisons: (1) Corn, barley, and dried sugar-beet pulp, each fed with alfalfa alone, are compared and also when fed with cottonseed cake and with linseed cake; (2) cottonseed cake is compared with linseed cake when fed with either corn, barley, or dried pulp; and (3) corn silage, beet-top silage, beet tops, and cull potatoes are compared when fed with a ration of corn, cottonseed cake, and alfalfa.

When the lambs had reached full feed, corn, barley, or dried pulp was fed at the rate of 1 pound per lamb daily, cottonseed cake at the rate of one-third pound, and silage or potatoes at the rate of 1.6 pounds. Where beet tops were fed, the lambs were given what

they would clean up. The lambs in each lot were fed all the alfalfa hay they would eat without unnecessary waste. The potatoes were run through a root cutter before they were fed.

The lambs were bought on the Denver market. The initial cost of the animals weighed into the feed lots, after allowing for the shrinkage to the feed lot and for freight paid to Omaha, was $12.60 per hundredweight for those bought in the fall of 1922, $12 for those bought in the fall of 1923, and $13.35 for those bought in the fall of 1924, the average cost was $12.65. The average initial weight per lamb was 48 pounds the first winter, 45 pounds the second, and 59 pounds the third winter, with an average initial weight of 51 pounds. All lots of lambs were appraised at the end of each feeding test by expert sheepmen. The "tops" were valued at $14.25 per hundredweight in the spring of 1923, $16 in 1924, and $16.85 in 1925. These valuations were the same as the quotations for tops at Omaha on the day the lambs were appraised. The average price of these tops for three years is $15.70. The appraised values herein used for the different lots are the averages of the three appraisals for that lot. A charge of 60 cents per lamb is allowed to cover interest and shipping cost. A shrinkage of 6 pounds per lamb is allowed from the feed lots to Omaha.

The average prices (per hundredweight except as stated) of the feeds that prevailed during the three winters are as follows: Corn, $1.65; barley, $1.20; molasses with dried pulp, $1.10; cottonseed cake and linseed cake, each $2.50; corn silage, beet-top silage, and cull potatoes, each $4 per ton; beet tops, 40 cents per ton yield of sugar beets; alfalfa, $11 per ton.

The quantities of feed per 100 pounds gain in weight of lambs in each of the lots are given in Table 15.

TABLE 15.—*Feed per 100 pounds of gain for 13 lots of lambs fed different rations for an average period of 116 days at the Scotts Bluff Field Station during the winters of 1922–23 to 1924–25*

Lot No.	Alfalfa	Corn	Barley	Dried pulp	Cotton-seed cake	Linseed cake	Corn silage	Beet-top silage	Beet tops (from tons of beets)	Cull potatoes
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		*Pounds*
1	683	335								
2	770		375							
3	851			422						
4	552	286			92					
5	660		312		100					
6	632			301	96					
7	590	288				92				
8	671		315			101				
9	638			306		98				
10	455	282			90		478			
11	476	272			87			462		
12	455	270			87				1.62	
13	488	263			84					447

The three years' results show that corn is a better feed for fattening lambs than barley and more so even than dried pulp when each of these feeds is fed without cake; but when one-third pound of cake is added to the respective rations there is not so much difference between the feeding value of corn and dried pulp; and dried pulp is equally as good as, or better than, barley. By comparing the feed require-

ment per 100 pounds gain in lots Nos. 1, 2, and 3, it can be shown that 100 pounds of corn had a replacement value of 112 pounds of barley and 26 pounds of alfalfa, or 125 pounds of dried pulp and 50 pounds of alfalfa; but when lots Nos. 4, 5, and 6, where cottonseed cake was fed, are compared, 100 pounds of corn equaled 109 pounds of barley, 2.8 pounds of cottonseed cake, and 38 pounds of alfalfa, or 105 pounds of dried pulp, 1.4 pounds of cottonseed cake, and 28 pounds of alfalfa.

Cottonseed cake seems to have a little higher feeding value than linseed cake when either is fed with corn, barley, or dried pulp.

Corn silage, beet-top silage, beet tops, and potatoes proved to have somewhat the same feeding value when fed with a ration of corn, cottonseed cake, and alfalfa. The potatoes ranked first and the corn silage last. It would not be practicable to grow potatoes for feed, but when they are already grown and there is no market for them, as often happens, they should be fed rather than left to rot. If fed, the expense of sorting and hauling to market and the cost of sacks are avoided. There are cull potatoes every year which should be fed rather than thrown away. The tops from 1 ton of sugar beets when siloed have about the same feeding value as the tops from 1.6 tons of sugar beets not siloed.

The results of this feeding experiment, showing gains made per lamb, cost of feed per 100 pounds of feed-lot gain, the appraised value for 100 pounds at the end of the feeding test, and the profit on lambs at Omaha are grouped in Table 16 to show the comparative value of the different rations.

TABLE 16.—*Results of using different rations in feeding 13 lots of lambs at the Scotts Bluff Field Station, 1923–1925*

Feeds and lots compared	Feeds used in the ration in addition to alfalfa hay	Feed-lot gains		Appraised value per 100 pounds	Net profit per lamb
		Per lamb (pounds)	Cost per 100 pounds of gain		
Corn, barley, and dry pulp (without cake):					
Lot No. 1	Corn	30.3	$9.27	$15.40	$1.75
Lot No. 2	Barley	27.0	8.74	15.30	1.61
Lot No. 3	Dried pulp	24.0	9.32	15.25	1.24
Corn, barley, and dried pulp (with cottonseed cake):					
Lot No. 4	Corn and cottonseed cake	35.4	10.06	15.65	1.97
Lot No. 5	Barley and cottonseed cake	32.4	9.88	15.55	1.79
Lot No. 6	Dried pulp and cottonseed cake.	33.7	9.19	15.50	2.05
Corn, barley, and dried pulp (with linseed cake):					
Lot No. 7	Corn and linseed cake	35.2	10.30	15.65	1.87
Lot No. 8	Barley and linseed cake	32.2	10.00	15.55	1.73
Lot No. 9	Dried pulp and linseed cake	33.1	9.33	15.50	1.97
Corn, silage, beet-top silage, beet tops, and cull potatoes (with corn, cottonseed cake, and alfalfa hay):					
Lot No. 10	Corn, cottonseed cake, corn silage.	36.0	10.48	15.70	1.90
Lot No. 11	Corn, cottonseed cake, beet-top silage.	37.2	10.33	15.65	1.97
Lot No. 12	Corn, cottonseed cake, beet tops.	37.4	9.95	15.60	2.08
Lot No. 13	Corn, cottonseed cake, cull potatoes.	38.4	10.13	15.65	2.10

Other feeds being the same, the lambs which were fed corn made more gains than those fed either barley or dried pulp. The spread was not so much when cake was fed in the rations as when it was omitted. The barley-fed lambs made more gains than pulp-fed lambs when neither were fed cake, but when cake was added to the ration dried pulp made more gains than barley. In the lots where cake was not fed, the lambs getting corn made 3.3 pounds more gain than those fed barley and 6.3 pounds more than those fed dried pulp, while in the lots getting cottonseed cake the corn-fed lambs made 3 pounds more gain than the ones fed barley and only 1.7 pounds more than those fed dried pulp. Lambs fed cottonseed cake or linseed cake sold for 25 cents per hundredweight more than those not fed cake. The lambs fed corn sold for 15 cents more and those fed barley 5 cents more per 100 pounds than the pulp-fed lambs.

A ration of cake fed with either corn, barley, or dried pulp increased the net profit per lamb, the greatest increase occurring when lambs were fed with dried pulp. The lambs fed dried pulp and alfalfa showed a profit of $1.24 each, but when cottonseed cake was added to this ration the profit was $2.05, an increase of 81 cents per lamb. Cottonseed cake made slightly more gains and returned profits higher than those of linseed cake.

The lambs fed corn silage were appraised at $15.70 per hundredweight, which was the highest of all lots, but for some unknown reason the gains made in the last winter were low. During the first two winters of the experiment these lambs made about the same gain as the lambs fed potatoes, but the last winter they fell short 6 pounds per lamb. The lot fed potatoes made an average gain of 38.4 pounds per lamb, which made this the high lot. This lot also made the highest profit, $2.10 per lamb.

PASTURING SWEET CLOVER WITH BROKEN-MOUTHED EWES AND LAMBS

In the fall of 1923, 44 broken-mouthed ewes were bought on the Denver market at an average cost of $5.43 each, delivered at the field station feed lot. These ewes were bred to a Hampshire buck, and the lambs were dropped the latter part of April. During the winter and until the ewes and lambs were turned on sweet-clover pasture, they were fed a total of 7.5 tons of corn silage, 3.73 tons of dried pulp, 0.28 ton of cottonseed cake, and 2.1 tons of alfalfa hay. (Fig. 5.)

During the latter part of the winter and at lambing time eight ewes died. In buying broken-mouthed ewes for breeding, one can well afford to pay more per head for good strong ewes rather than to buy worn-out ewes even at considerably less money. If the ewes have lost most of their teeth and are in a run-down condition, more expensive feed will be required, such as concentrates, in wintering them, than for stronger ewes that have fairly good teeth. The death rate is also higher with old "gummers." These ewes were sheared the last week in April and yielded a fraction less than 8 pounds of wool each.

On May 2, 36 ewes and 38 lambs were turned into a 3-acre field of sweet clover. While on pasture the ewes and lambs were fed a total of 5,500 pounds of ground corn and 3,000 pounds of dried pulp. These ewes and lambs were shipped September 12 to St. Joseph, Mo.,

where the ewes sold for $6 and the lambs for $13 per 100 pounds, or a total over and above the shipping cost of $545.30. The wool sold for 37 cents a pound. After charging the ewes for all their winter and summer feed (sweet clover at $20 an acre) and interest on the investment, they showed a net profit of about $2 a head. This takes into account the eight ewes that died. Had the death loss not been so high, the returns would have been considerably more. The results are summarized in Table 17.

FIG. 5.—Broken-mouthed ewes and their lambs on sweet-clover pasture, Scotts Bluff Field Station

TABLE 17.—*Results of pasturing broken-mouthed ewes and lambs on sweet clover supplemented with grain, at the Scotts Bluff Field Station, 1923*

Data compared	Results	Data compared	Results
Time on pasture ... days	132	Gains made:	
Number on pasture:		Ewes ... pounds	540
Ewes	36	Lambs ... do	2,320
Lambs	38		
Initial weight:		Total	2,860
Ewes ... pounds	3,850		
Lambs ... do	650	Feed per 100 pounds gain:	
Final weight:		Ground corn ... pounds	195
Ewes ... do	4,390	Dried pulp	105
Lambs ... do	2,970	Sweet clover (3 acres)	0.1

In 1925, 7 acres of sweet clover were pastured with broken-mouthed ewes and lambs. The pasturing season was divided into two periods. The first period extended from April 28 to July 1 and the second period from July 2 to October 7. Two lots of ewes and lambs were pastured during the first period. One lot of 40 ewes with 42 lambs which were lambed before the end of April was kept on 3 acres; and in the other lot, which had access to 4 acres of sweet-clover pasture, there were 75 ewes with 78 lambs which were lambed after the ewes were placed on pasture. The lot of 40 ewes and their lambs was fed 1 pound of grain per head while on pasture, and the lot of 75 ewes and their

lambs was fed only a light grain ration during the first part of the period, after which the lambs received grain at the rate of one-half pound daily per lamb.

On July 2 the 40 ewes with 36 of their lambs and 15 ewes from the 75-ewe lot were shipped to market. The ewes sold for an average of $4.50 and the lambs for $14 per 100 pounds.

From July 2 until October 7 there were 69 ewes and 122 lambs on the 7-acre pasture. Up to this time 9 of these ewes and 44 lambs had been used in a test in which grain, corn silage, and alfalfa hay were fed in a dry lot. While on pasture these 122 lambs were fed one-half pound of dried pulp per lamb daily. Six lambs from the two sweet-clover pasture lots died during the spring and early summer from castration, docking, and other causes.

A total of 7.21 tons of dried pulp, 1,025 pounds of corn, and 1,796 pounds of cottonseed cake were fed to the ewes and lambs on 7 acres during the season. The ewes made 845 pounds of gain and the lambs 6,265 pounds, or a total of 7,110 pounds. For each 100 pounds of gain, 202 pounds of dried pulp, 14 pounds of corn, 25 pounds of cottonseed cake, and one-tenth acre of sweet-clover pasture were required. The results are summarized in Table 18.

TABLE 18.—*Results of pasturing broken-mouthed ewes and lambs on 7 acres of sweet clover supplemented with grain, at the Scotts Bluff Field Station, 1925*

Data compared	In weight	Out weight	Data compared	In weight	Out weight
Initial weight:	*Pounds*	*Pounds*	Total gains made:	*Pounds*	*Pounds*
115 ewes	12,510	--------	Ewes	845	--------
120 lambs	3,015	--------	Lambs	6,265	--------
Removed from pasture July 2:					
55 ewes	--------	6,645	Total	7,110	--------
36 lambs	--------	2,630			
Increase made July 2:			Feed per 100 pounds gain:		
9 ewes	880	--------	Dried pulp (14,415)	--------	202
44 lambs	2,260	--------	Corn (1,025)	--------	14
Final weight October 7:			Cottonseed cake (1,796)	--------	25
69 ewes	--------	7,590	Sweet clover (7 acres)	--------	0.1
122 lambs	--------	8,910			

At the end of the pasturing season there were 122 lambs averaging 73 pounds in weight. Lambs similar to these were selling at 14 to 15 cents in the Denver markets. The 69 ewes averaged 110 pounds in weight and would have sold for $5.50 at the market.

To winter these ewes and also those fed corn silage in the dry lot required an average of 185 pounds of dried pulp, 40 pounds of cottonseed meal, 500 pounds of corn silage, and 250 pounds of alfalfa per ewe. In the spring the ewes sheared within a fraction of 9 pounds of wool each, this wool sold for 40 cents a pound. When the ewes and lambs are charged $20 an acre for the sweet-clover pasture, market prices for the additional feeds supplied them during the winter and summer, and the interest on the investment, the total operation showed a profit of about $3.25 per ewe.

SWEET-CLOVER PASTURE AND CORN SILAGE COMPARED

In the spring of 1925 a test was made to compare the feeding value of sweet-clover pasture with that of corn silage for fattening broken-mouthed ewes and April-dropped lambs, and to obtain information on

two methods of feeding grain to ewes and lambs. One method was to feed all the grain in one pen to ewes and lambs together; the other method was to feed only part of the grain to both ewes and lambs and the remainder of the grain to the lambs in a separate pen.

There were three lots. Lot No. 1 containing 40 ewes and 42 lambs was pastured on 3 acres of sweet clover, and 50 pounds of dried pulp and 10 pounds of cottonseed cake were fed daily to both ewes and lambs; and 20 pounds of dried pulp, 16 pounds of corn, and 4 pounds of cottonseed cake were fed to the lambs in a separate pen. This is the same lot reported under the discussion covering the pasturing of sweet clover with broken-mouthed ewes and lambs in 1925. In lot No. 2 fed in a dry lot there were 20 ewes and 22 lambs which received the same quantity of concentrates per head and were fed in the same manner as those in lot No. 1. The ewes and lambs in lot No. 2 were fed corn silage and alfalfa instead of being placed on sweet-clover pasture. In lot No. 3 were 20 ewes and 22 lambs which were fed the same ration as lot No. 2. Instead of a part of this ration being fed to the lambs in a separate pen, however, all of the grain was fed in one pen to both ewes and lambs together. This experiment began April 28 and closed July 2. A summary of the results is given in Table 19.

TABLE 19.—*Results of pasturing broken-mouthed ewes and lambs on sweet clover supplemented with grain and corn silage at the Scotts Bluff Field Station, 1925*

Data compared	Lot No. 1, sweet-clover pasture, grain divided	Lot No. 2, silage, grain divided	Lot No. 3, silage and grain, fed together
Number of ewes	40	20	20
Number of lambs	42	22	22
Initial weight:			
Ewes ... pounds	4,300	2,300	2,260
Lambs ... do	1,210	600	630
Final weight:			
Ewes ... do	4,825	2,345	2,385
Lambs ... do	2,870	1,310	1,185
Gains made:			
Ewes ... do	525	45	125
Lambs ... do	1,660	710	555
Total ... do	2,185	755	680
Average gain:			
Ewes ... do	13.1	2.3	6.3
Lambs ... do	39.5	32.3	25.2
Feed per 100 pounds gain:			
Alfalfa ... do	----------	324	408
Corn silage ... do	----------	600	662
Dried pulp ... do	205	297	329
Corn ... do	47	68	75
Cottonseed cake ... do	41	59	66
Sweet-clover pasture—60 days ... acre	0.136	----------	----------

The ewes and lambs in lot No. 1 had access to 3 acres of sweet clover for 60 days. In addition to the pasture feed, they received a total of 2.24 tons of dried pulp, 1,024 pounds of corn, and 896 pounds of cottonseed cake. Those in lots Nos. 2 and 3 were both fed 1.12 tons of dry pulp, 512 pounds of corn, 448 pounds of cottonseed cake, and 2.25 tons of corn silage for each lot; those in lot No. 2 were fed 1.25 tons of alfalfa, and those in lot No. 3, 1.39 tons of alfalfa.

The average gain per ewe was 13.1 pounds when pastured on sweet clover. In lot No. 2 the average gain per ewe in experiments in which part of the grain was fed to lambs in separate pens, was 2.3 pounds; and in experiments in which the grain was fed to both ewes and lambs together the gain was 6.3 pounds per ewe. The lambs in lot No. 1 made an average gain of 39.5 pounds, those in lot No. 2, 32.3 pounds, and those in lot No. 3, 25.2 pounds. Both ewes and lambs made an average gain of 52.6 pounds on sweet clover as compared to 34.6 pounds when fed corn silage and alfalfa hay in the dry lot. In experiments where the lambs were fed grain in a separate lot, the ewe and lamb made 34.6 pounds gain, and where the grain was fed to the ewe and lamb in one lot the gain was 31.5 pounds. In a dry lot experiment where corn silage and alfalfa were fed, considerably more grain and cake were required per 100 pounds gain than on sweet-clover pasture.

By comparing the feed requirements per 100 pounds gain in lots Nos. 1 and 2, it will be noted that 1 acre of sweet-clover pasture for a period of 60 days had a feeding value equal to 1.19 tons of alfalfa hay, 2.2 tons of corn silage, 676 pounds of dried pulp, 154 pounds of corn, and 132 pounds of cottonseed cake.

From the standpoint of total gains, there does not appear to be a great deal of difference between the results from experiments in which the grain is fed so that the lambs get a larger part or whether it is fed in one pen, ewes and lambs eating together. In this test there was a small difference in favor of feeding in separate pens. The greatest advantage, however, in feeding the grain so that the lambs get a larger share is that lambs will make more gains from a given quantity of grain than will old ewes, and, furthermore, the gain in the case of lambs brings a higher cash return than the gain on ewes.

Under the prices that have been prevailing during these sweet-clover pasturing tests with steers and broken-mouthed ewes and lambs, the latter have proved far more profitable than steers. A big factor in favor of sheep is that less grain is required per 100 pounds of gain. The average of these tests shows that when ewes and lambs were on a full feed of grain with sweet-clover pasture, 300 pounds of grain (dried pulp, corn, and cottonseed cake) was required for each 100 pounds of gain made; while with steers and hogs 750 pounds of grain (mostly corn) was required for 100 pounds of gain. In the case of sweet-clover pasture a little more perhaps is required for sheep than for steers and hogs, but sweet-clover pasture is usually cheap compared with the price of grain.

The wool crop from good ewes will almost pay the winter feed bill. The ewes pastured in 1924 sheared 8 pounds per head, and those pastured in 1925 sheared 9 pounds per head. During the winter of 1925–26 the grade Hampshire breeding ewes kept at the station were wintered on alfalfa and corn silage. For this purpose 350 pounds of alfalfa and 565 pounds of silage per ewe were required. During the same winter, each of the 69 broken-mouthed ewes kept on sweet-clover pasture during the summer of 1925 consumed a total of 180 pounds of dried pulp, 40 pounds of cottonseed cake, 500 pounds of silage, and 280 pounds of alfalfa.

PASTURING EXPERIMENT WITH STEERS

The steers used in the sweet-clover pasturing tests in 1923 were bought on the Denver market April 23. They were 3-year-olds, white or brock-faced, and very thin. They had been wintered in Colorado, but originated farther south. They would have been classed as fair to good stockers. At Denver they averaged 703 pounds in weight and cost $7.90 per hundredweight with freight paid to the river markets. When put on test the average weight of these steers was 757 pounds. There were 75 steers divided into three uniform lots of 25 steers each. The pasturing test began May 16. Lot No. 1 was put on sweet clover and fed corn, lot No. 2 on sweet clover without grain, and lot No. 3 on an 800-acre pasture of native grass. The sweet clover was about 8 or 10 inches high when the steers were turned on it. For the first few days the steers did not seem to relish it, but after a week or 10 days they developed a liking for it. When they began eating the sweet clover, they grazed it very unevenly. This was true of both lots. In small patches—9 or 10 feet square—the sweet clover was eaten off very close to the ground, while in other places it was hardly touched. The rather coarse succulent stems appeared to be more palatable than the leafy part of the plant. Where the sweet clover was eaten so close to the ground it killed out badly. Under farm conditions it is advisable to begin pasturing sweet clover rather early but not too heavily, and then to increase the number of stock as the season advances and the carrying capacity increases.

In the beginning of the experiment the pasture for each lot of steers was divided and the steers alternated from one to another. There was 1 acre to every three steers. After the killing of the sweet clover as the result of uneven grazing, three steers per acre proved to be too many in lot No. 2, while in lot No. 1 there were not enough to utilize all of the pasture. For a while half of the pasture that was originally meant for lot No. 1 was used by the steers in lot No. 2. A 3-acre field of sweet clover in another part of the farm, also, was used by lot No. 2 for a part of the season. With the poor stand of sweet clover obtained, about 1 acre was required for two steers in lot No. 2, while 1 acre for four steers during June and July was sufficient in experiments where corn was fed, as in lot No. 1.

It required 72 days to bring the steers in lot No. 1 up to a ration of 20 pounds of corn per steer per day. They were started on corn when put on pasture. The ration was increased as rapidly as they would take it until on August 5 they were consuming 20 pounds per steer per day. This rate of consumption continued until the close of the test, October 6. The total consumption of corn for the entire period of the test per steer was 2,094 pounds.

The steers in lot No. 2 were removed from the sweet-clover pasture and taken to the 800-acre native-grass pasture on August 13. This change was made for two reasons. First, the nights were getting cooler, and the sweet clover was blooming so that the pasture was not producing the amount of feed it did earlier in the season, and it was thought advisable to make the change in order to be sure of enough pasture for the steers in lot No. 1. The second reason was that the steers in lot No. 2 were not doing nearly so well as the

steers on grass pasture. On September 12 the steers in lot No. 1 were changed to a new field of sweet clover which had been seeded in the spring with barley and had made considerable growth after the barley was harvested. They were kept on this pasture until October 6.

On June 7 six shotes, weighing a total of 800 pounds, were put behind the steers in lot No. 1, and on July 9 five more shotes, weighing 870 pounds, were added. These 11 shotes, weighing a total of 2,920 pounds, were removed September 9. They were replaced with 18 spring pigs weighing 1,225 pounds. At the end of the experiment the 18 pigs weighed 1,625 pounds. Neither lot of hogs was fed any additional feed. The total gain made by the hogs following the steers was 1,650 pounds, or 66 pounds of pork per steer.

Considerable trouble was experienced with the steers from bloating. This trouble, however, always occurred when the steers were changed to fresh pasture, perhaps because they were held on the old pasture too long. When the dividing fence was removed so that they had access to all the pasture, no more trouble was experienced from bloat. Two steers in lot No. 2 died from bloat, and the trocar was used on three others—two from lot No. 2 and one from lot No. 1.

The steers in lot No. 3, which were on native-grass pasture, did very well. The average gain per steer was 225 pounds, as compared with 255 pounds for the steers in lot No. 1 and 133 pounds for those in lot No. 2. There was an unusually large amount of rainfall during the summer, and the grass made very good growth.

The three lots of steers were shipped to Omaha on October 6 and each lot sold separately on a very poor market. The steers in lot No. 1 sold for $8 per hundredweight, those in lot No. 2 for $5.40, and those in lot No. 3 for $6. The steers in lot No. 1 showed a financial loss of $19.40 per steer, those in lot No. 2 a loss of $21.46 per steer, and those in lot No. 3 a loss of $8.82 per steer. Table 20 gives a summary of the experiment.

TABLE 20.—*Results of pasturing steers on native grass and on sweet clover, with and without corn, at the Scotts Bluff Field Station, 1923*

Data compared	Lot No. 1, sweet clover and corn	Lot No. 2, sweet clover	Lot No. 3, native grass
Time of test ... days	135	[1] 135	135
Number of steers in lot	25	25	25
Average weight:			
Initial, on pasture ... pounds	757	757	757
Final, at Omaha ... do	1,012	890	982
Gains made per steer ... do	255	133	225
Corn fed per 100 pounds of gain ... do	822	----------	----------
Pork made per steer ... do	66	----------	----------
Financial statement:			
Initial cost per hundredweight, freight paid	$7.90	$7.90	$7.90
Market price at Omaha, per hundredweight	8.00	5.40	6.00
Loss per steer (including pasture and interest charges)	19.40	21.46	8.82

[1] Of this period, the steers were on sweet-clover pasture the first 82 days and were changed to native pasture for 52 days.

Two lots of 12 steers each were used in 1924. They were bought on the Denver market in November, 1923, weighed an average of 812 pounds per steer and cost $8 per hundredweight. They were

wintered at the station and weighed 974 pounds per steer when put on pasture. Lot No. 1 was put on sweet-clover pasture with corn and dried beet pulp and lot No. 2 on 800 acres of native-grass pasture. It required about 40 days to get these corn-fed steers up to full feed, which consisted of 15 pounds of corn and 5 pounds of dried pulp. The test closed September 12, when lot No. 1 was shipped to Omaha and sold on a very poor market. The commission company in reporting the sale stated:

> Cattle the weight of yours have been selling very badly the past 10 days. * * * Your cattle were fat and right good quality. * * * All heavy cattle are meeting the same fate, and as a rule cattle feeders are losing from $25 to $40 a head on all the heavy cattle they are selling now.

The steers on native-grass pasture, in lot No. 2, were weighed after being driven 6 miles from pasture and kept in dry lot overnight. They showed a gain of 126 pounds per steer for the summer. This low gain is accounted for by the poor feed, which was caused by a very low rainfall during the spring and summer. The steers in lot No. 1 made 251 pounds gain and sold for $9.25 per hundredweight, showing a loss of $3.77 each. The steers in lot No. 2 were valued at $7.70 per hundredweight and showed a loss of only $0.22 per steer.

The results of the feeding test with these two lots of steers are summarized in Table 21.

TABLE 21.—*Results of pasturing steers on native grass and on sweet clover with supplementary feed at the Scotts Bluff Field Station, 1924*

Data compared		Lot No. 1, sweet clover and supplement	Lot No. 2, native grass
Time of test	days	135	135
Number of steers in lot		12	12
Average weight:			
Initial, on pasture	pounds	974	974
Final, at Omaha	do	1,225	1,100
Gains made per steer	do	251	126
Fed per 100 pounds of gain:			
Corn	do	697	----------
Dried pulp	do	275	----------
Pork made per steer	do	72	----------
Financial statement:			
Initial cost per hundredweight, freight paid		$8.00	$8.00
Market price at Omaha		9.25	7.70
Loss per steer (including pasture and interest charges)		3.77	.22

The averages from the two tests show that the steers on sweet-clover pasture with grain made 253 pounds gain per steer and required in addition to the pasture 759 pounds of corn and 137 pounds of dried pulp for each 100 pounds of gain. An average of 66 pounds of pork per steer was made from hogs following the steers.

The steers on native-grass pasture made very good gains during the summer of 1923, but those pastured during 1924 did not do so well. The average gain per steer for the two summers was 175 pounds.

STEERS ON RANGE PASTURE

Eight hundred acres of native grassland 5 miles northwest of the station are used as a pasture. The results from four lots of steers grazed on this land are available. In 1920, 82 head of steers were

pastured from June 3 until October 23, a total of 142 days. Of these steers, 47 were yearlings and 35 were 2-year-olds. Both lots of steers were thin in flesh. The average initial weight for the yearlings was 473 pounds, and for the 2-year-olds 708 pounds. The final average weights were 675 pounds for yearlings and 931 pounds for 2-year-olds. The average gain made by yearlings was 202 pounds, and by 2-year-olds 223 pounds. The precipitation for the spring and summer was 13.91 inches.

During the summer of 1922, 29 two-year-old steers with an average initial weight of 878 pounds were pastured from May 14 to October 1. Their average final weight was 1,045 pounds, showing an average gain of 167 pounds. These steers had been on a full feed of wet pulp and alfalfa hay during the winter and were in very good flesh when put on pasture. The rainfall for the spring and summer was 12.67 inches.

The 25 steers pastured during the summer of 1923 were the same lot reported in Table 20. They were 3-year-olds and very thin in flesh when put on pasture. Their average initial weight was 757 pounds and their average final weight 982 pounds, showing a 225-pound gain. The rainfall for the spring and summer, 16.6 inches, was unusually high.

Twelve 2-year-old steers with an average initial weight of 974 pounds were grazed during the summer of 1924. They were wintered at the station on beet tops, corn silage, and alfalfa hay and were in good flesh when put on pasture. This is the same lot of steers reported in Table 21. Their final average weight was 1,100 pounds, an average gain of 126 pounds per steer. The rainfall during the season, 7.72 inches, was very light.

A summary of the gains made by the four lots of steers grazed on this land is given in Table 22. In all there were 148 steers on pasture for an average of 138 days. The steers made an average total gain of 198 pounds, or 1.43 pounds daily. The highest gains were made in the summer of 1923 and the lowest in 1924. In 1923 the total rainfall was 20.2 inches, which produced an abundance of feed, while in 1924 the feed was short, owing to a scant rainfall of only 9.95 inches.

TABLE 22.—*Results of pasturing steers on native grass, at the Scotts Bluff Field Station, 1920, 1922–1924*

Data compared	1920	1922	1923	1924	Average
Rainfall during spring and summer ..... inches	13.91	12.67	16.60	7.72	12.72
Time on pasture ..... days	142	140	135	135	138
Number of steers	82	29	25	12	37
Average weight:					
Initial ..... pounds	574	878	757	974	697
Final ..... do	785	1,045	982	1,100	895
Gains made ..... do	211	167	225	126	198
Daily gain ..... do	1.49	1.19	1.67	0.93	1.43

WINTERING STEERS

The twenty-four 2-year-old steers used in the pasturing tests during the summer of 1924 were bought at Denver in the fall of 1923 and wintered at the station on alfalfa, beet tops, and corn silage. They were good to choice feeders and weighed 812 pounds at Denver. During a period of 136 days of the winter they were fed a total of 29.28 tons of alfalfa, 17.04 tons of corn silage, beet tops from 155

tons of sugar beets, and 3 tons of dried pulp. To winter each steer required an average of 1.22 tons of alfalfa, 0.71 ton of silage, the tops from 6.5 tons of sugar beets, and 250 pounds of dried pulp. Dried pulp was fed only during the latter part of the test in order to get the steers accustomed to eating it, so that the ones put on sweet-clover pasture could be quickly brought up to a full grain ration.

The average weight per steer after a week's fill on alfalfa hay at the station was 821 pounds, and at the end of the test the steers averaged 974 pounds each. This represented an average gain of 153 pounds each. The steers were in good flesh in the spring.

THE DAIRY HERD[2]

The dairy herd at the station consists of 12 purebred and 8 high-grade Holstein females. (Fig 6.) The purebreds, with the exception of two heifers, are all descended from two foundation cows that

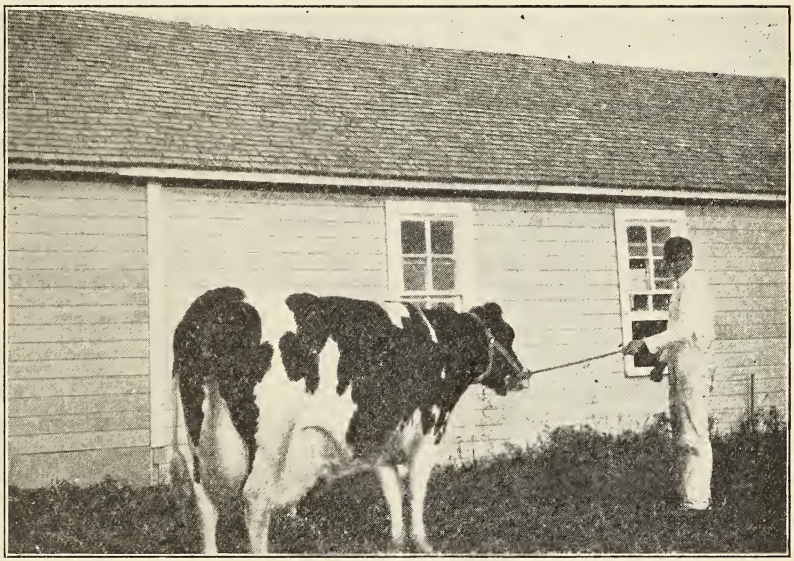

FIG. 6.—Holstein cow Nebraska Colantha Spofford, owned at the Scotts Bluff Field Station

were purchased in 1919. No purebred females have ever been disposed of. A purebred Holstein bull has been in service in the herd since 1916. Of the purebred females there are five mature cows, one 3-year-old, three 2-year-olds, and three yearlings. Of the grade there are two mature cows, two 3-year-olds, two yearlings, and two heifer calves.

During the summer season, May to October, the cows and heifers run on either bluegrass or sweet-clover pasture. The rest of the year they are fed alfalfa and silage. Some silage is usually fed during the summer months. During the winter seasons the cows have access to an open shed and are kept in the barn only while being milked.

[2] D. H. Propps, of the Office of Demonstrations on Reclamation Projects, Extension Service, United States Department of Agriculture ,has direct charge of this work and prepared this report.

TABLE 23.—*Number of cows in milk, roughages and concentrates fed, and production of milk and butterfat each month, at the Scotts Bluff Field Station, 1925*

Months	Number of cows		Total feed consumed (pounds)			Days on pasture	Total production (pounds)	
	In milk	Dry	Alfalfa	Silage	Concentrates [1]		Milk	Butterfat
January	7	5	8,280	16,120	2,940	--------	8,456	308.0
February	11	1	6,360	14,560	2,540	--------	8,393	303.8
March	11	1	7,080	16,120	2,854	--------	12,260	439.3
April	11	1	6,840	15,600	2,811	--------	11,257	404.4
May	11	1	2,020	14,880	2,821	31	12,098	434.6
June	11	1	--------	7,200	2,620	30	11,433	410.7
July	11	1	--------	6,820	2,139	31	9,708	349.7
August [2]	10	1	--------	6,200	1,573	31	8,073	293.8
September	10	1	--------	6,000	1,240	30	7,442	268.6
October	9	2	5,830	12,400	1,422	--------	7,093	256.2
November	8	3	5,225	12,000	1,709	--------	6,618	244.2
December	8	3	7,150	12,400	1,958	--------	5,757	207.5
Average	10	2	6,098	11,690	2,219	--------	9,049	326.7

[1] Concentrates: 1 part each of molasses with dried pulp, ground barley, and cottonseed meal and 2 parts bran.
[2] Cow died.

TABLE 24.—*Individual records of cows in the dairy herd at the Scotts Bluff Field Station, 1922–1925*

Designation of cow	1922			1923		
	Milk (pounds)	Butterfat		Milk (pounds)	Butterfat	
		Pounds	Per cent		Pounds	Per cent
Grades:						
No. 2, Ellen	8,833	308.0	3.5	12,148	436.7	3.6
No. 3, Stinnie	9,028	287.2	3.2	11,557	383.6	3.3
No. 4, Goldie [1]	9,211	314.9	3.4	12,255	431.2	3.5
No. 5, Lenora	6,163	248.9	4.0	9,330	355.3	3.8
No. 6	--------	--------	--------	--------	--------	--------
No. 7	--------	--------	--------	--------	--------	--------
No. 16 [2]	--------	--------	--------	7,183	238.3	3.3
Purebreds:						
No. 101, Colantha	10,002	392.5	3.9	12,356	475.8	3.9
No. 102, Colantha S.[3]	12,887	471.5	3.7	14,712	489.2	3.3
No. 103, Esther	1,548	63.4	4.1	8,344	345.0	4.1
No. 106, Easter [4]	--------	--------	--------	6,459	203.3	3.1
No. 108	--------	--------	--------	--------	--------	--------

Designation of cow	1924			1925		
	Milk (pounds)	Butterfat		Milk (pounds)	Butterfat	
		Pounds	Per cent		Pounds	Per cent
Grades:						
No. 2, Ellen	11,335	404.2	3.6	9,141	329.2	3.6
No. 3, Stinnie	7,840	259.4	3.3	9,990	329.6	3.3
No. 4, Goldie [1]	8,931	311.6	3.5	5,392	189.0	3.5
No. 5, Lenora	9,075	344.9	3.8	10,247	389.8	3.8
No. 6	--------	--------	--------	9,144	311.2	3.4
No. 7	--------	--------	--------	8,094	323.7	4.0
No. 16 [2]	2,535	83.7	3.3	9,606	316.9	3.3
Purebreds:						
No. 101, Colantha	11,327	442.8	3.9	12,123	472.8	3.9
No. 102, Colantha S.[3]	16,310	573.9	3.5	7,850	274.7	3.5
No. 103, Esther	12,576	507.1	4.0	10,101	404.0	4.0
No. 106, Easter [4]	5,232	167.6	3.2	6,855	219.3	3.2
No. 108	7,205	259.6	3.6	10,045	360.6	3.6

[1] Died July, 1925. [2] Dry for six months in 1924. [3] Dry for six months in 1925. [4] Died August, 1925.

Concentrates are fed to cows in milk and to dry cows and heifers in preparation for freshening. While in milk each cow is fed concentrates in proportion to her daily milk production. When linseed meal is available the following mixture of concentrates is used: Dried pulp, 100 pounds; ground corn or barley, 100 pounds; linseed meal, 100 pounds; cottonseed meal, 60 pounds. When linseed meal can not be had, the feed used is a mixture of equal parts of the other concentrates.

The total quantity of concentrates and roughage fed, the number of cows in milk, and the total quantity of milk produced each month are shown in Table 23. The number of days the herd was on pasture is indicated under each month during the pasturing period. The individual production records of the cows are shown in Table 24.

BULLS LENT TO BULL CLUBS

The best of the purebred bulls raised at the Scotts Bluff Field Station are lent to groups of farmers on the project who own small herds and who will form bull clubs. In each club the total number of cows owned by the members must be sufficient to use a bull at something like full capacity. Arrangements are made for other farmers in the vicinity of each club to use the bull upon the payment of a fee of $2, $1 of which is retained by the keeper of the bull, the other $1 turned over to the station to become a part of a bull-club fund used in extending the work. With the exception of the fee requirements, the agreement under which the bulls are lent to clubs is similar to the one employed by the Bureau of Dairy Industry of the department in lending bulls to farmers.

The first bull club was organized in 1923 and a bull was placed in service on February 10. The heifers by this bull began to freshen in the fall of 1925, so none of them has completed the first lactation period. However, three of the daughters of this bull in the station herd, where he was used the year before he was lent to the club, have completed one lactation period. Two of these are grades and the other is a purebred. The milk records of the grade heifers show a 30 per cent increase over the records of their dams as 2-year-olds and the milk record of the purebred heifer shows a 25 per cent increase over her dam's record as a 2-year-old. Table 25 shows the records of the three heifers in the station herd and the record of their dams as 2-year-olds.

TABLE 25.—*Records of three heifers and their dams, as 2-year-olds at the Scotts Bluff Field Station*

Designation	Production (pounds)		Increase (per cent)	
	Milk	Butterfat	Milk	Butterfat
Dam (purebred)	8,013	231		
Daughter	10,121	344	26	49
Dam (grade)	6,758	223		
Daughter	8,784	307	30	37
Dam (grade)	6,163	246		
Daughter	8,094	323	31	31

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